MACHINERY

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SHOP PRACTICE OF THE WILLYS-OVERLAND CO.*

EVOLUTION OF A FOUR-THROW CRANKSHAFT—MACHINING FLYWHEELS, CAM-SHAFTS, ETC.

BY DOUGLAS T. HAMILTON†

THE Willys-Overland Co., Toledo, Ohio, employs many interesting shop methods and tools in the manufacture of the Overland automobile. A description of the forging and machining of the crankshaft and other parts is given in the following.

Drop-forging Crankshafts

The crankshaft used in the four-cylinder engines built by the Willys-Overland Co. is made by drop-forging a high carbon manganese steel bar, 38¼ inches long by 2⅜ inches in diameter, to the desired shape under powerful steam hammers. The long bars of stock are first sheared to the correct length in a power shear, after which they are taken to a furnace beside the drop-hammer where they are heated to a bright red. When the bars attain the desired temperature they are quickly removed by the "heater" one at a time, and passed to the steam hammer operator. This man first places the rod over the breaking down impression on the die shown in Fig. 2, and then operates the hammer; as the top die descends, it forces the heated rod into the impressions in the breaking-down die. The operator now, by holding the heated bar in a pair of large tongs, quickly shifts the bent bar to the roughing impression (shown to the right of the die in Fig. 2), where it is given another blow. The bar is moved back and forth from the breaking-down to the roughing impression until it has been formed roughly to the desired shape, two blows in each impression generally being sufficient for the purpose. While forcing the heated bar into the impression in the die, a certain amount of scale is formed, which is removed by directing a blast of compressed air onto the face of the die.

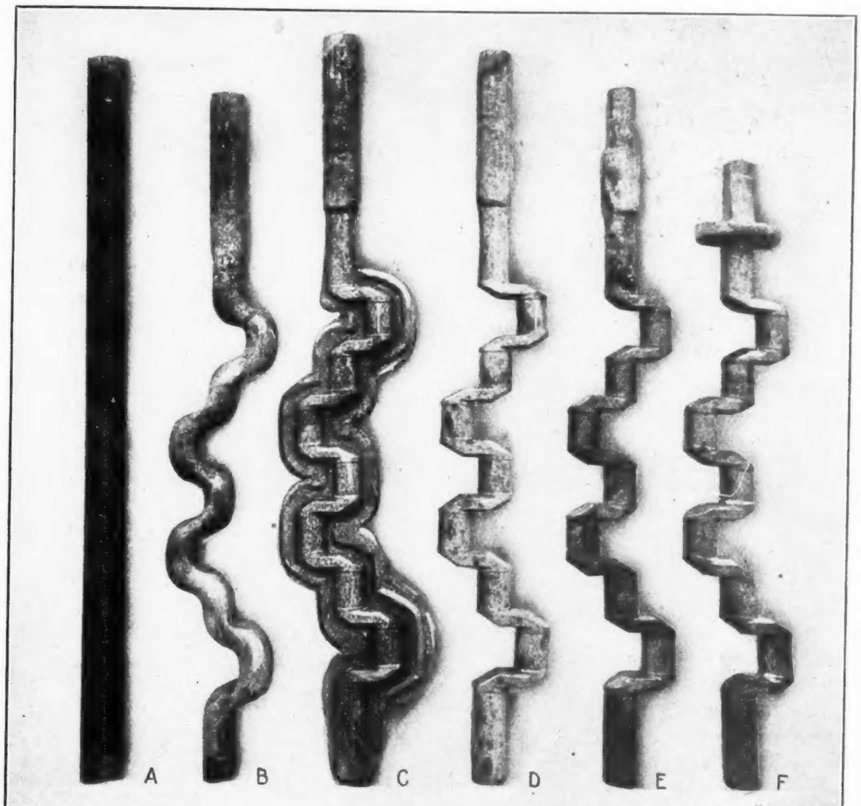

Fig. 1. Evolution of a Four-throw Crankshaft from the Straight Bar to the Final Shape—Illustrating Sequence of Drop-forging and Upsetting Operations

The shape of the crankshaft, after passing through the roughing dies, is shown at *B* in Fig. 1. After rough-forming, the crankshaft is placed on the finishing die shown set up in a Chambersburg steam hammer in Fig. 4, a closer view of the lower die appearing in Fig. 3. The steam hammer is now operated, and the top die forces the already roughly formed bar into the finishing impression. As the bar is not heated, but is taken directly from the roughing to the finishing dies, it usually requires from two to three blows to bring it to the final shape. The appearance of the crankshaft after the final drop-forging operation is indicated at *C* in Fig. 1, where it can be seen that the excess metal has been flashed out. Grooves cut around the impression in the finishing die are provided to take care of this excess metal. The crankshaft is now taken to a power press in which are held a trimming punch and die for removing the flash formed in the final drop-forging operation. The crankshaft, as it appears after the flash is removed, is shown at *D* in Fig. 1.

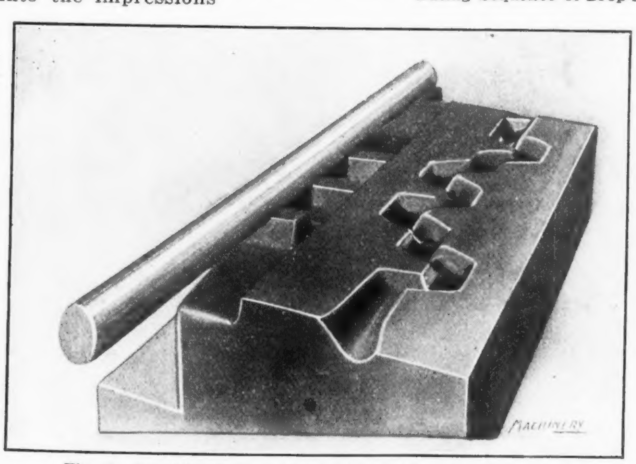

Fig. 2. Breaking-down and Rough-shaping Drop-forging Die

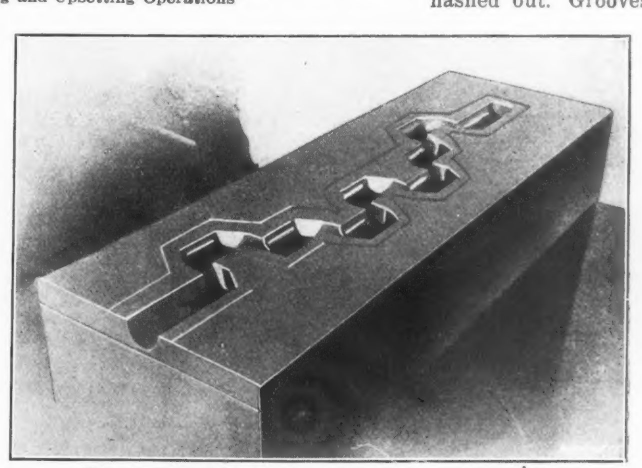

Fig. 3. The Finish Drop-forging Die for the Crankshaft

After the flash has been removed, the crankshaft is again

*For information on automobile shop practice previously published in MACHINERY, see "Methods, Machines and Fixtures for Automobile Manufacture," December, 1911, and other articles there referred to.
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taken to the furnace, and the opposite end (flange end by which it was gripped when being drop-forged), is heated to the correct temperature. The heated bar is then taken to a power hammer, where the long end is reduced in diameter, see *E*, Fig. 1, to fit the hole in the plunger of a 4-inch Ajax upsetting and forging machine, where the flange upon which the flywheel is subsequently attached, is formed. After reducing the diameter of the long end, the crankshaft is again taken to the furnace and this end heated. The next and final forging operation is illustrated diagrammatically in Fig. 5. In this illus-

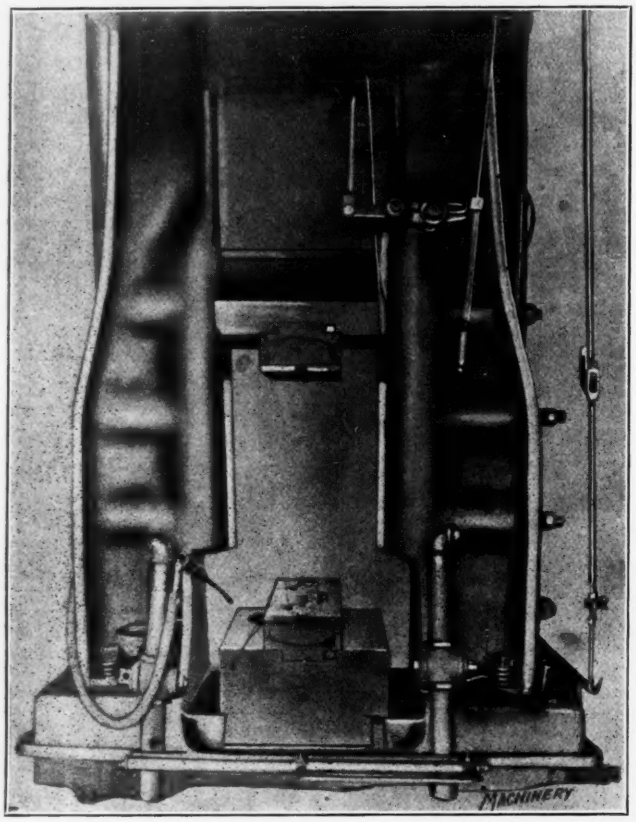

Fig. 4. Chambersburg Steam Hammer with the Finish Drop-forging Dies in Place

tration, only one of the gripping dies is shown, the views being sectional elevations to show the operations more clearly.

The gripping dies which hold the crankshaft while the flange is being formed by the upsetting plungers *b* and *c*, are known as "double-deck" gripping dies, as they are provided with two

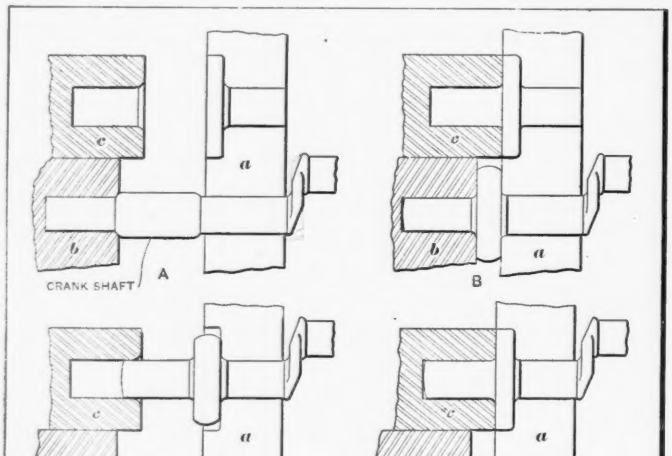

Fig. 5. Diagram illustrating the Evolution of the Flange on the Crankshaft which is produced in a Four-inch Ajax Upsetting and Forging Machine in Two Blows

impressions enabling the flange to be rough- and finish-formed without removing the crankshaft from the machine. The diagram at *A* shows the crankshaft located in the lower impression in the gripping die *a*, and also in place in the lower upsetting plunger *b*. When in this position, the machine is operated, and as the ram advances, the lower plunger upsets the flange to the shape shown at *B*. The ram now retreats and the operator removes the crankshaft from the lower impression in the gripping dies, placing it in the upper

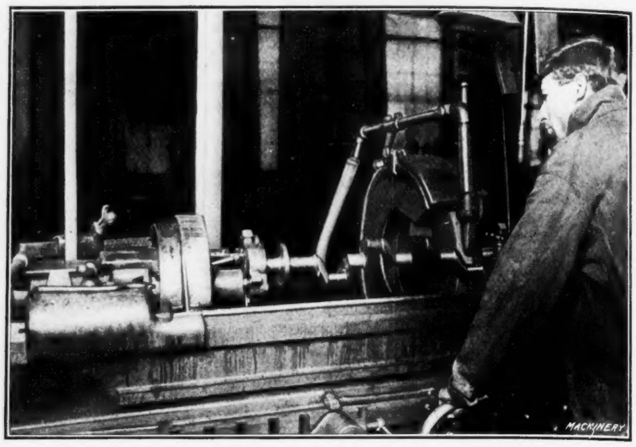

Fig. 6. Rough-grinding the Crank-pins in a Norton Grinder

impression as shown at *C*. The machine is again operated, and as the ram advances, plunger *c* forces the roughly formed flange into the large impression in the gripping dies, forming it to the correct shape as illustrated at *D*. As a rule only two blows are required to completely form the flange to a diameter over two and three-quarters greater than the bearing portions.

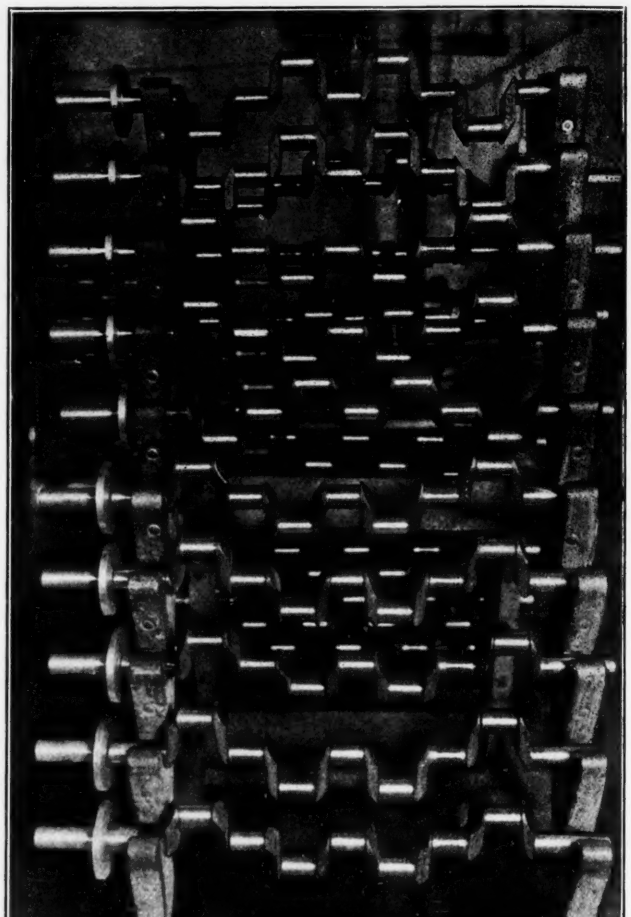

Fig. 7. Rack used for holding Crankshafts when transporting them from One Operation to another

One of these gripping dies is stationary, whereas the other is movable, enabling the bar to be inserted and removed easily—the dies automatically stay open when not in operation.

The condition of the crankshaft after it leaves the forging machine is shown at *F* in Fig. 1. This is the final forging operation, and when cool, the crankshafts are transferred to the heat-treating department. The forging operation sets up internal strains in the bar, which can only be removed by annealing. The crankshafts are next straightened and heat-treated. After heat-treating they are centered on each end, and

in this condition pass to the lathe department. Here the main end bearings are rough-turned and the flange roughed out; then the crankshaft is cut to the proper length, centered, and the flange faced. The crankshaft is now placed in an American crankshaft lathe where the faces of the throws are machined to the proper width to admit the rough grinding wheel. Two tools are used in this operation so that the space between the "arms" of the throw is machined to the correct width in one setting.

From the lathe department the crankshafts are taken to the grinding department where all portions are ground to size, except the flange and the end on which the clutch cone is mounted. The first grinding operation consists in roughing down the crank-pins in a Norton grinder to within 0.025 inch of the finish size. This operation is illustrated in Fig. 6, where it can be seen that a wheel the exact width of the space between the arms of the throws is used; this is fed directly into the work until the proper diameter is reached. When grinding the crank-pins the crankshaft is held by both ends in fixtures attached to the headstock and tailstock of the grinder, which are offset sufficiently to give the desired amount of eccentricity.

The crankshafts are now taken to another grinder of the same type as that illustrated in Fig. 6, where the crank-pins are ground to the desired diameter, 1.500 inch. The bearings are then finish-ground, and upon the completion of this operation the crankshafts are returned to the lathe department for a few minor operations. For conveying from one machining department to another, a special type of rack is used as shown in Fig. 7. This is built on the pyramid plan and holds twenty crankshafts. It is mounted on small wheels enabling it to be moved about easily. After leaving the lathe department the crankshafts pass through a few minor operations and then receive the final inspection, after which they are ready for assembling in the engines.

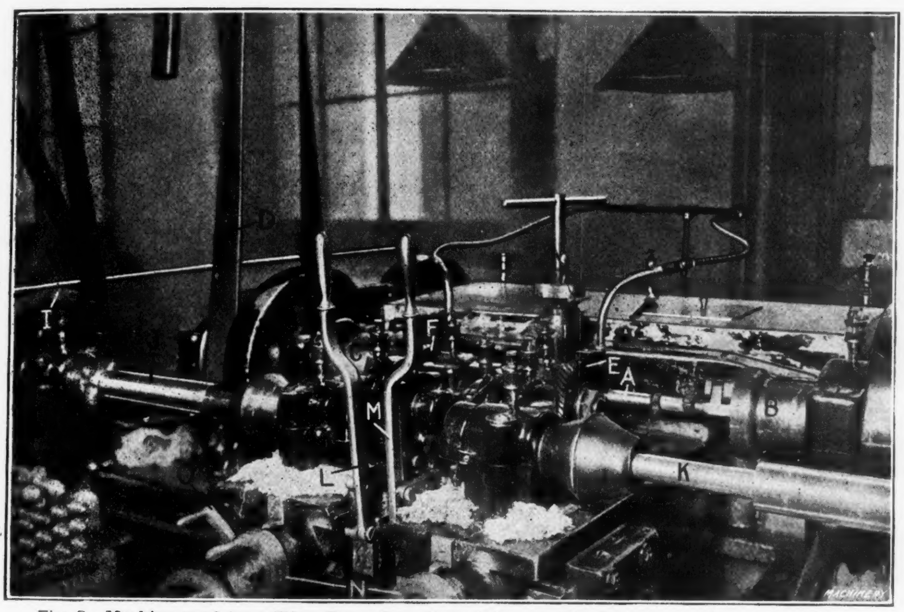

Fig. 8. Machine used for milling Cams, Two Cams being machined at one Setting of the Cutters

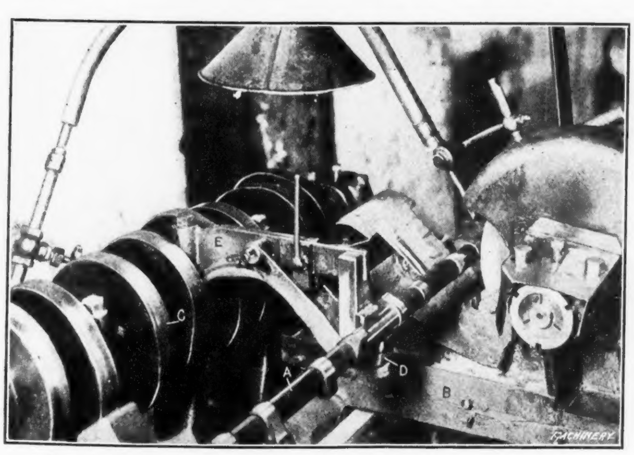

Fig. 9. Le Blond 16-inch Engine Lathe rigged up with Special Fixtures for grinding Cams

Machining and Gaging Cam-shafts

The cam-shaft, which is also made from a bar of high-carbon manganese steel, is drop-forged to shape under a steam hammer, three die impressions being used, two for roughing and one for finishing. After drop-forging and trimming, it is taken to the heat-treating department and annealed; then cut to the required length and centered in each end. It is now ready to be turned between the cams, which operation is performed in a "Lo-Swing" lathe. From the lathe, the cam-shafts are taken to the special cam milling machine shown in Fig. 8, which was designed and built by the Willys-Overland Co. especially for this work. The cam-shaft *A*, which has been provided with a locating flat on each end, is retained by swinging clamps in two special holders *B* and *C*; these holders are held on spindles in heads which are driven by belts *D* (only one of which is shown) from the countershaft. The spindle carrying the master cams is located immediately behind the heads driving the cam-shaft *A* and is connected to these heads by spur gears of an equal ratio, so that both work and master cams rotate at the same speed. These master cams are similar in shape to those shown in Fig. 9.

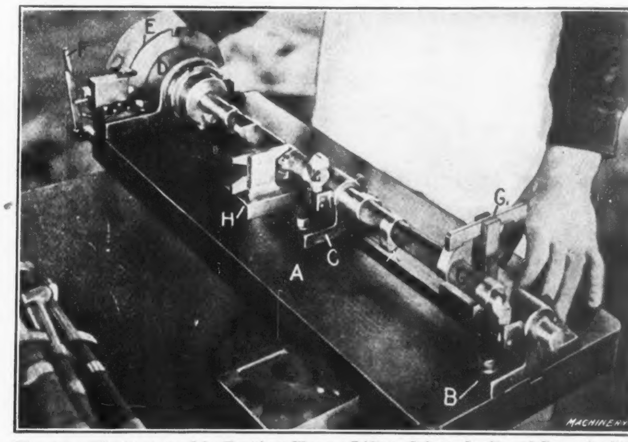

Fig. 10. Fixture used in Testing Shape, Lift and Angularity of Cam-shafts

The two milling cutters *E* and *F*, which do the machining, are mounted on spindles located in heads which are fastened to the cross-slides shown. The milling cutters are driven by two pulleys *I*, which are belted to the countershaft and transmit power through knuckle-jointed shafts *J* and *K* and gears to the cutter-spindles. The cross-slides are operated to withdraw the milling cutters from the work by two handles *L* and *M*, which pull the slides back to a stop by a link connection. The slides are fed forward by a screw, which is provided with micrometer collars *N* and is engaged with the half-nut by operating the levers *O*, one of which is provided for each slide.

In operation, after the cam-shaft has been properly located in the chucks, and the slides moved over to bring the helical milling cutters in line with the two innermost cams, the operator pushes the handles *L* and *M* forward, then engages the half-nuts with the screws and the machine operates automatically, the half-nuts disengaging from the screws when the desired depth is reached. At the same time that the milling cutters are at work, the slides on which they are held are being oscillated back and forth by the master cams, connection being made to rollers in contact with the latter. When the two cams have been completed, the operator withdraws the slides, and moves them apart until the milling cutters are in line with the next set of cams, then forces the slides in and engages the half-nuts, as previously described. This procedure is followed until the four sets—eight cams—have been milled. The cam-shaft is well supported against the thrust of the milling cutters, so that two cams are completed for every revolution of the shaft.

After milling, the cam-shafts are taken back to the hardening department where they receive the final heat-treatment. The next operation consists in straightening those cam-shafts which have become slightly distorted during the final heat-treating process. Then they are taken to the grinders, where the bearings are ground to the required size. The next operation consists in grinding the eight cams to the desired shape and size in the special machine shown in Fig. 9, which is a 16-inch LeBlond engine lathe that has been fitted up with a special slide holding an emery wheel in place of the ordinary tool-post slide. Brackets fastened to the back of the machine carry a shaft on which the eight master cams *C* are held. A hardened and ground roll held on the wheel-slide *B* is kept in contact with the master cams by a suspended weight.

In operation, the cam-shaft *A* is held as shown in Fig. 8, and one cam is ground to size at a time—0.020 inch being removed from the "diameter." The cam-shaft is supported on the center bearing by a special leather-faced shoe *D*, which is retained in a bracket adjustably mounted on the arm *E*. When one cam is ground to size, the slide carrying the wheel is moved along until the roll comes in contact with the next master cam, when the operation is repeated, the wheel being fed in directly against the work. Water is used on the wheel and work to

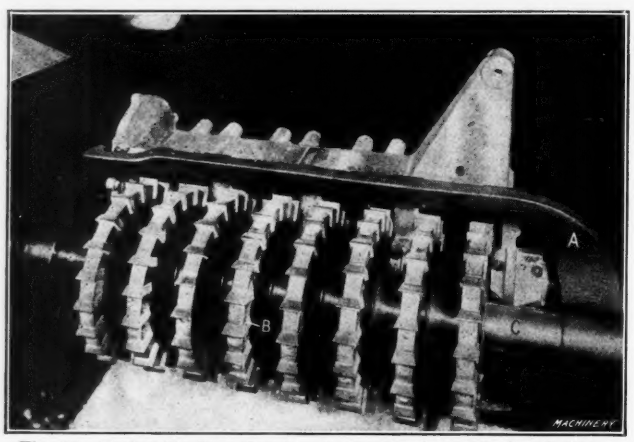

Fig. 11. Facing the Five Bearings in the Crank-case in One Setting on a Lucas Boring, Drilling and Milling Machine

make the wheel free-cutting and prevent the work from heating.

This completes the manufacturing operations on the cam-shafts, and they are now turned over to the inspection department, where the cams are tested for shape, lift and angularity. The testing fixture used for this purpose is shown in Fig. 10. It comprises a bedplate *A* on which three brackets *B*, *C* and *D* are held. Brackets *B* and *C* are used as supports only, and are provided with hinged caps held by thumb-screws, to facilitate the insertion and removal of the cam-shaft. The bracket *D*

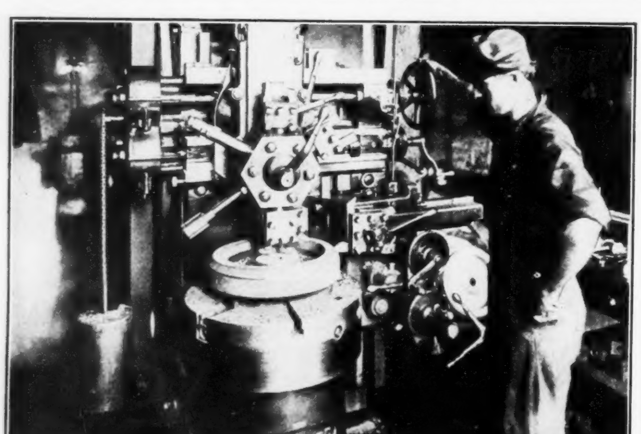

Fig. 12. Machining Flywheel in One Setting on a Bullard Vertical Turret Lathe

carries a special chuck for gripping the work, and is furnished with an indexing disk *E* which has eight notches to correspond with the number and position of the cams on the shaft. This disk is located in the various positions by a tapered plunger, which is held in contact with the disk by a spring and is removed by the handle *F*, to index the disk.

The highest point of the cam is tested by the T-gage *G* which is provided with "go" and "not go" points on the bar G_1. The angularity and shape of the cams are tested by the V-gage *H*; this is provided with knife-edge gaging points, and is used in connection with the indexing disk to test the angularity and position of the cams on the shaft. It is also provided with "go" and "not go" V-grooves, which are made to the exact

Fig. 13. Threading Speed Rods in Geometric Threading Machines at the Rate of 90 Rods per Hour

shape desired. All three brackets are located from a groove in the bed, so that they are in perfect alignment.

Facing Crank-case Bearings

Fig. 11 shows the method used in facing the five main bearings in the aluminum crank-case. For this operation, the crank-case is held on trunnions in the fixture *A* which is fastened to the table of a Lucas boring, drilling and milling machine. The facing is accomplished with eight inserted-tooth milling cutters *B*, which are held on the cutter-arbor *C*, being separated by washers as shown. These cutters are fed directly

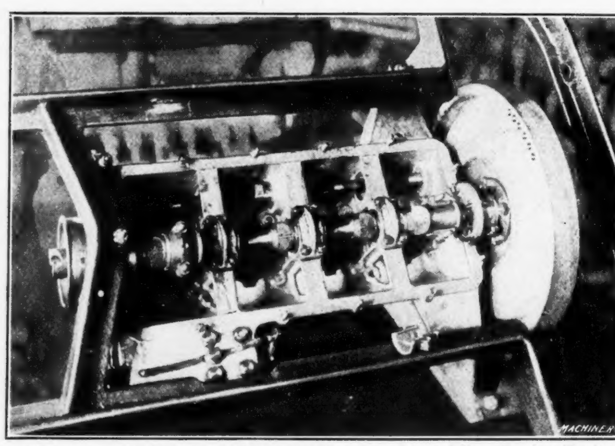

Fig. 14. Rotating Trunnion Stand used in Assembling Engine Parts

in toward the bottom of the case and face the five bearings in one operation. The caps are fastened on before the crank-case is placed in the fixture.

Machining Flywheels

The flywheels used on the Overland engines are machined complete in one setting, with the exception of facing the lower hub, on Bullard vertical turret lathes. Fig. 12 shows one of these machines at work on a flywheel, which is held by the hub in the chuck of the machine. The tools held in the side head are used for rough- and finish-turning the rim and bevel face, whereas the other three tool-heads held in the turret carry turning tools for rough- and finish-facing the top of the flange, inside face of the flange, and hub. The boring-tool is used for roughing out the bore, which is finished to the exact size by the reamer, also held in the turret. As the side head and cross-rail head are operated independently of each other, it is possible in this machine to be working on the circumference and face of the work at the same time, which naturally increases the production to a marked extent over that of a machine which is adapted for performing only one operation at a time.

Threading Speed Rods

The threads on speed rods are cut in a Geometric threading machine as shown in Fig. 13. These rods are 7/16 inch in diameter and are threaded for 1⅜ inch, with a 14 pitch thread. No previous machining operations are accomplished on these rods, the thread being cut on the rough bar. In action, the rod is placed in the vise by the operator and set to the desired length by the swinging stop shown. The machine, which has been set to trip at the proper moment—when the thread has been cut for the proper distance—then works automatically, the chaser dies opening to allow the rod to be removed without backing out. The operator then draws the carriage back, removes the work from the vise, and repeats the order of operations on the succeeding rods. The thread produced is clean and accurate in every respect, and what is more interesting, is produced at the rate of ninety threads per hour.

Engine Assembling Stand

A stand built on the trunnion principle as shown in Fig. 14, is used for holding the engine while assembling the various members. The engine is held to this stand in the same manner as when in place in the car, being fastened to the frame by three-point support holes. The top portion of the frame to which the engine is attached can be swung around to any desired position, enabling the assembler to get at any part of the engine easily. The rapidity with which an engine can be assembled when held in this manner is really remarkable.

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MACHINING GASOLINE ENGINE GOVERNOR VALVES

BY JOHN F. WINCHESTER*

One of the interesting pastimes of a machinist or toolmaker is to figure out the best and most economical method of doing a certain piece of work. In many instances the mechanic receives instructions from the foreman as to how the necessary operations are to be performed, or he is governed by the jigs which have been designed for the work. But whether he is under the direction of a superior or allowed to use his own judgment in regard to the work, his object is to do an economical job. After the "cut" is started, the mechanic will recall former experiences with different equipment and wonder if he would not have been able to do the job more economically if part of the old equipment were at his disposal.

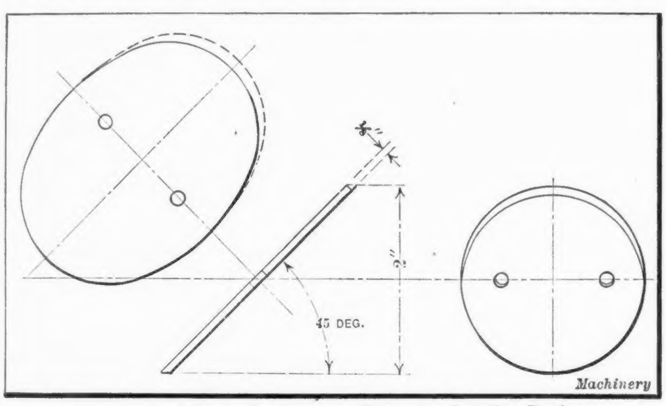

Fig. 1. Oval Butterfly Governor Valve for Gasoline Engine

We often see two shops doing the same work in totally different ways, although both may possess practically the same equipment. This is due to the reasoning done by the executive heads, each of whom would swear by his own particular method. The writer's attention was recently attracted by such a case where the job in question consisted of machining gasoline engine governor valves in small quantities. Entirely different methods were employed by the two firms.

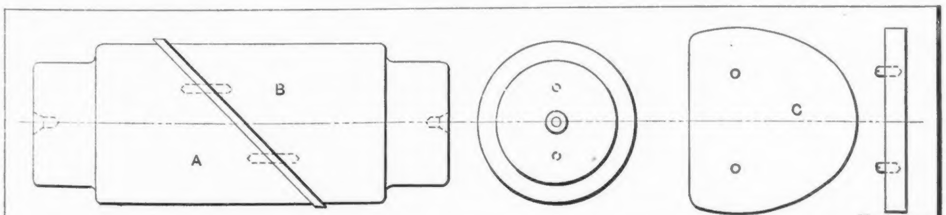

Fig. 2. Split Arbor for turning Valves in Lathe and Templet for filing

Fig. 1 shows the work to be machined, which was accomplished by the first firm as follows: The valve was first cut to a rough outline from ⅛-inch sheet brass, and two screw holes were drilled. The work was then placed upon the arbor illustrated in Fig. 2 and turned to size, after which the corner indicated by dotted lines in Fig. 1 was hand filed to the templet C. The arbor was made of tool steel, split at an angle of 45 degrees. The two guide pins pass through the screw holes in the valve. These pins are a driving fit in A and a slip fit in B, the valve being held in position by them. It can be seen that placing this arbor between the centers of the lathe causes it and the work to be held together.

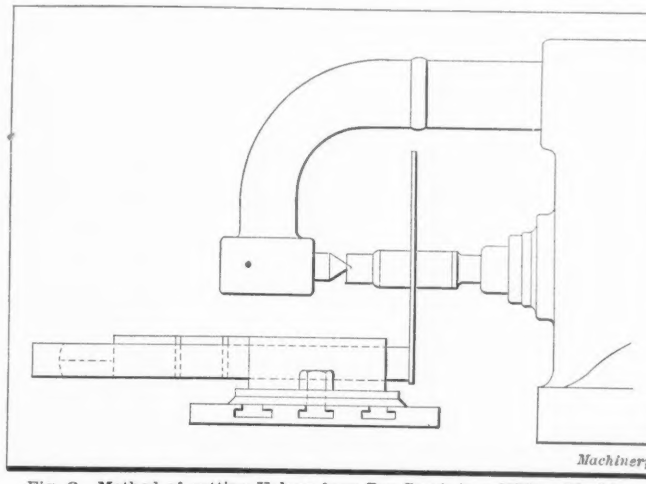

Fig. 3. Method of cutting Valves from Bar Stock in a Milling Machine

The second firm solved the problem in the following manner: A bar of brass stock of the proper diameter was sent to the milling department, where a machine was set up with a 1/16-inch saw and a universal vise turned to an angle of 45 degrees with the cutter. The bar was then clamped in place with the end projecting sufficiently to allow a number of pieces to be cut off before it was moved. With the aid of the dial index, it is obvious that these pieces could be cut off accurately and quite rapidly. After this operation they were drilled, then filed to the templet shown in Fig. 2. Fig. 3 shows the operation being performed.

An analysis of these two methods shows that the first one required a great deal of hand labor, a waste of sheet metal such as always takes place in a job of this kind, and a specially made arbor suitable only for this particular job. The time required for turning was no small item, as it is readily seen that the tool was "cutting wind" to a great extent to accomplish the desired result. In contrast, we find that the second method required no hand labor except to file the valve down to the templet and remove the burrs caused by the milling cutter; a very small amount of waste resulted, as compared with the first method and no investment was needed for special tools, as the saw used to cut blanks from the bar could be used for any similar work on the milling machine.

* * *

An interesting use of polarized light to locate stresses in machine members was described in *Nature*, December 5. A pair of cut gear wheels, made of a nitro-cellulose compound similar to celluloid, were run together under load, while polarized light was transmitted through the rims and teeth in engagement. The condition of internal stress was marked by color fringes which appeared as black bands when photographed. The possibilities of this method of analyzing the stresses in models of machine members, building frames, bridges, etc., are apparently great. Many puzzling questions may be easily settled and new facts of much importance discovered regarding the distribution of internal stresses.

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PLANING OR MILLING—WHICH?

In the manufacture of special machinery, large numbers of cast-iron rails, each from twelve to sixteen feet long, were required to be milled on two faces at right angles to each other. One of these pieces is shown in detail in Fig. 1, and the machining of the two faces comprises the machine work on the piece. As these pieces are finished in large numbers, the question arose as to the most economical method of doing the work—by planing or milling. In either case the purchase

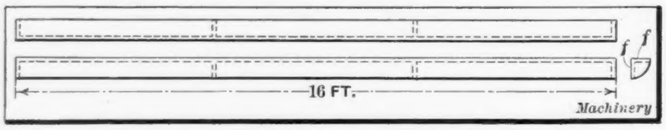

Fig. 1. One of the Pieces to be machined

of a machine was necessary, and if a milling machine was used the outlay for cutters would be considerable. After some consideration it was decided to plane the pieces, and a Cincinnati planer was installed, as shown in Fig. 2. This illustration also shows some of the pieces to be finished and gives a general idea of the way the work was handled. By referring to Fig. 3 in connection with Fig. 2, it will be seen that seven sets of special dogs were used with provision for holding eight of the rails. The cross-rail of the planer was provided with eight tool-holding heads, four of which were equipped with roughing tools and four with finishing tools. By mounting four rough rails at one side of the planer table and four rough-planed rails on the opposite side, it was possible to perform eight cutting operations, four of which were roughing and four finishing. After roughing four rails, they are moved over to the finishing side of the planer table and four castings are rough-planed again while the previous four rails are being finished. By using the type of dog shown, it is insured that the cuts will be at right angles to each other. Each of the tools is adjustable independently of the others on the cross-rail, and any tool may be removed for sharpening and replaced easily. With this equipment it is believed by the users that planing is more economical than milling for this particular job.

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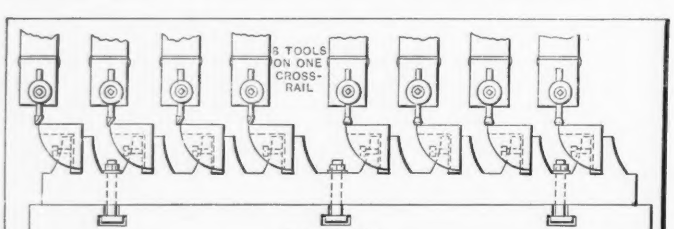

Fig. 3. How the Work was held and machined

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"GENERAL ELECTRIC REVERSING MOTOR DRIVE"—CORRECTION

The table of comparative tests of planers equipped with belt drive and direct-connected reversing motor drive which accompanied the description of the "General Electric Reversing Motor Drive" in the January number contained two errors, *viz:* The return speed in feet per minute in the twelfth column, fifth line from top, should be 59.3 instead of 599.3; and the cut in inches, sixth column last line should be 1/2 by 1/16 and 1 by 1/16 for the 72- by 22-inch reversing motor planer, the same as for the belt planer, same size just above.

AT THE AUTO SHOW—BOOSTING THE GAME

"No," said the oil salesman. "I never knock a competitor's goods—it isn't good policy. I believe in boosting the game even if the other fellow does make a sale right under my nose once in a while. I'd rather he made the sale than to have neither of us make one.

"Yes, I know you don't want any oil now, but I've been coming to the auto show ever since it started and I've seen a bunch of people. I remember a lot of them that come up here to see me every year. Last year perhaps they had no car, but now they have and they're interested in what I've got to sell 'em, but that's not what I was going to tell you about boosting the game.

"At one show several years ago, a fine-looking old gentleman came up to me and began to talk about oil. He had made up his mind to buy a certain make of car—the Squedunk we'll say—and wanted to use the best oil—that's my Slick oil. Well I told him what my oil is and why it would give him satisfaction. He said that he would want a barrel just as soon as he got the car.

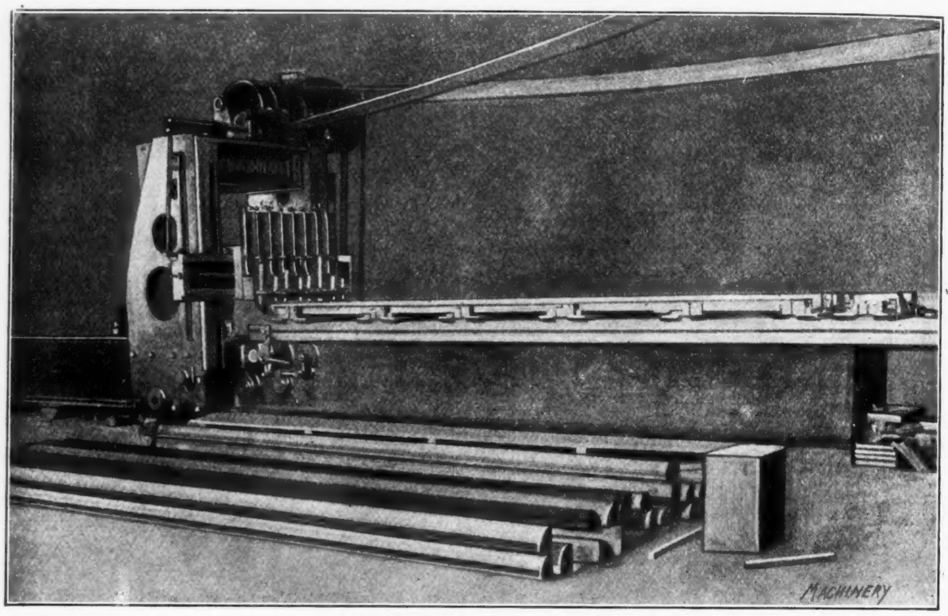


Fig. 2. The Planer and the Work

"The next day he came again, but he wasn't looking happy. 'Bought the car yet?' I asked.

"'No,' he said, 'and I'm not going to buy one now.'

"'Why, I thought the sale was as good as clinched,' said I.

"'So it was, but it's all off now, and I'm thoroughly disgusted with auto salesmen, or rather one in particular.'

"Then he told me what the trouble was. He had made up his mind to buy a car of the same make as the one owned by a friend, and had seen the agent. The agent had invited him to come to the show and see the latest model. But the old gent got mixed on the name or location and went to see another car. The salesman got hold of him and finding out that he was going to buy the Squedunk car began to knock it for fair. The Squedunk car was the worst ever. Why you were likely to lose a wheel, break a spring or blow up the engine every time you took it out. Many unfortunate owners had been brought back to their sorrowing friends crushed and mangled beyond recognition just because they had insisted on buying Squedunk cars.

"Well, the old gent let the agent pump it into him until he concluded he didn't want any car and wouldn't take one as a gift. The result is that he has never bought one, although he's able to have a half-dozen and probably would have two or three now if that fool agent had boosted the game. My motto is, get trade and let the other fellow get some too, but that gink didn't see that he was spoiling business for everyone when he spun out that line of talk.

"So long! Have a circular, and remember Slick oil when you get the car. She sure will run some if you use that dope. Take it from me."

HARDENING SMALL NOVO STEEL MILLING CUTTERS

When it is impossible to grind a small milling cutter after hardening because of its irregular shape, "Novo" steel as a rule cannot be used. This is due to the high heat to which this steel must be brought before it will harden correctly; and as the sharp edges of the tool are generally burnt before the proper heat is obtained, it is evident that irregular shaped cutters cannot be successfully made from this brand of steel, when hardened by ordinary methods. This no doubt has been the experience of many mechanics who, knowing the good cutting qualities of this steel, have endeavored to make as many cutters as possible from it.

After having made numerous experiments in an endeavor to satisfactorily harden small form cutters made from "Novo Superior" steel, Mr. J. E. Lehman of the Universal Machine Tool Co., Canton, Ohio, has adopted a method which gives remarkably good results. After the cutters are finished and ready for hardening, they are packed in powdered charcoal in a wrought-iron pipe. The cutters are separated from each other and also from the wall of the pipe with a one-half inch layer of charcoal, and the same amount is placed upon the top of the work after it has been packed.

The pipe with the work packed in it is now placed in an ordinary forge fire and is heated slowly. When the pipe commences to show signs of fusing on the outside, it is removed from the fire and placed directly in fish or kerosene oil. The dipping must be done quickly to prevent the oil from catching fire. When cool, the pipe and its contents are removed from the bath and the work is taken out. If the heating has been carried on slowly and in the manner described, it will be found that the work is glass-hard, free from scale and just as sharp as it was before being put in the fire.

A similar experiment was tried with Stubs steel. First, a piece of steel was cut off the bar and hardened carefully in an open fire. It was then dipped in oil, and when cool was gripped between the jaws of a bench vise and given a blow with a hammer. As was expected, it broke without bending. Another piece of steel from the same rod was packed in charcoal in the manner previously described, then heated slowly and quenched in oil. The heat, however, in this case was not as high as that used for "Novo" steel, the pipe only being brought to a "bright yellow heat." The piece of steel thus hardened was gripped between the jaws of the bench vise and an attempt made to break it with an ordinary machinist's hammer. Several sharp blows were required to break this piece, and it bent considerably before fracturing. This experiment proved that the steel hardened in this manner was not only harder, but was also much tougher than when heated carefully in an open fire.

Packing the work in powdered charcoal not only provides a more even heat, but it prevents the heated parts from coming in contact with the air when in the highly heated state. Scale on the work is thus prevented and furthermore it saves heating small pieces to a considerably higher heat, as the temperature is not reduced in transferring the parts from the fire to the cooling bath.

D. T. H.

* * *

STANDARDS FOR HOSE COUPLINGS

Hose couplings for 2½, 3, 3½ and 4½-inch sizes have been standardized and adopted by the American Waterworks Association, The New England Waterworks Association, the National Firemen's Association, the National Fire Protection Association, etc., and up to January 1, 1910, more than two hundred towns and cities in the United States had also adopted this standard, details of which have been published in MACHINERY's Data Sheet Book No. 1, "Screw Threads." For sizes under 2½ inches, however, there is no universal standard; there are at least six different so-called "standards" used, known as follows:

Eastern gage hose thread (used in the New England States); Pacific Coast hose thread, known also as the California standard hose thread (used on the Pacific Coast); Chicago hose thread (used in the Middle West); Pittsburg hose thread; Boston hose thread; and the iron pipe thread, which is the general standard for pipe threads.

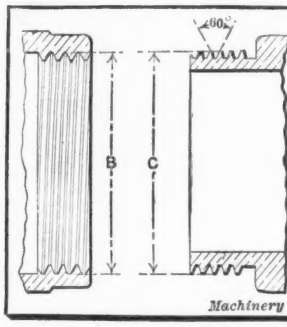
Table I, prepared by the aid of a table furnished by the Elkhart Brass Mfg. Co., Elkhart, Ind., gives a comparison of the dimensions of the outside diameter and the number of threads in the various sizes. Tables II and III give complete dimensions for the California standard hose and Chicago hose thread, as furnished by the Crane Co. of Chicago. In addition to these "standards," there is a great diversity of 2½-inch threads used by the fire departments of various cities. As regards the standards, there is no absolute agreement as to the dimensions, so that it is possible that some manufacturers deviate slightly from those given in the tables. It will be seen, for example, that the number of threads per inch as given in Table I for 1-inch Pacific Coast or California hose thread differs from the number given for the same thread in Table II. The only actual standard is that of the iron pipe thread, which, of course, is extensively used in all parts of the country.

TABLE I. COMPARISON OF HOSE COUPLING THREADS

Nominal Size	Eastern Hose Thread		Pacific Coast Hose Thread		Pittsburg Hose Thread		Boston Hose Thread		National Std. Hose Thread		Iron Pipe Thread	
	Outside Diam.	No. of Threads per Inch	Outside Diam.	No. of Threads per Inch	Outside Diam.	No. of Threads per Inch	Outside Diam.	No. of Threads per Inch	Outside Diam.	No. of Threads per Inch	Outside Diam.	No. of Threads per Inch
¾	1 1/16	11	1 1/16	11	1 3/16	11½	1 1/16	11	....	....	1.050	14
1	1 5/16	11½	1 5/16	11½	....	....	1 15/32	11	....	....	1.315	11½
1¼	1 23/32	11½	1 57/64	11	....	....	....	....	....	...	1.660	11½
1½	1 31/32	11½	2 9/64	11	....	....	....	....	....	....	1.900	11½
2	2 35/64	8	2 13/32	10	....	....	....	....	....	....	2.375	11½
2½	3 1/32	7½	3	7½	....	....	....	....	3 1/16	7½	2.875	8
3	....	....	...	....	....	....	...	....	3⅝	6	3.500	8
3½	....	....	....	....	....	....	....	....	4¼	6	4.000	8
4½	....	....	...	....	....	....	....	....	5¾	4	5.000	8

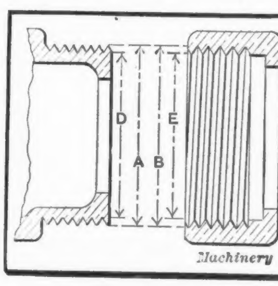
Machinery

TABLE II. CALIFORNIA STANDARD HOSE COUPLING THREAD



Nominal Size	B	C	No. of Threads per Inch	Clearance between Male and Female Thread
¾	1.080	1.070	11	0.010
1	1.320	1.310	11	0.010
1¼	1.860	1.850	11	0.010
1½	2.120	2.110	11	0.010
2	2.560	2.550	10	0.010
2½	3.050	3.040	7½	0.010

TABLE III. CHICAGO STANDARD HOSE COUPLING THREAD



Nominal Size	A	B	D	E	No. of Threads per Inch
¾	1.081	1.099	0.931	0.949	11½
1	1.295	1.315	1.145	1.165	11½
1¼	1.705	1.723	1.580	1.598	11½
1½	1.946	1.964	1.796	1.814	11½
2	2.522	2.542	2.306	2.326	8
2½	3.043	3.047	2.812	2.816	7

* * *

The 800,000-pound capacity Riehle testing machine of the Fritz engineering laboratory, Lehigh University, is being utilized for the testing of rails by the rail committee of the American Railway Engineering Association. These tests are expected to aid materially in the effort to reduce the number of defective rails. M. H. Wickhorst of Chicago, engineer of tests of the association's rail committee, is in charge of the work and is being assisted by members of the several engineering departments of the university. The present phase of the research is that of investigating the rate of reduction of the cross-section of rails in rolling from the ingot to the finished rail. One hundred pieces of 100-pound American Railway Association section, each two feet long, are being used.

DANGERS OF CONCRETE CONSTRUCTION

The falling of a concrete stairway at the Nostrand Avenue station of the Long Island R. R. in Brooklyn which caused the death of a man, has called wide-spread attention to the danger of imperfect concrete construction. The general and growing use of concrete in the construction of factories, warehouses, office buildings, bridges, tunnels, culverts and a thousand other structures, makes the possible hidden defects of concrete a serious menace to the safety of life and property. It is a great pity that so useful a building material—one that can be readily molded to any form—should be so dependent on the honesty of contractors for its integrity. The opportunities for saving a large percentage of the cost of a job by the use of poor cement and little of it and the chances of detection are so small, unless the work is rigidly watched and inspected at every step, that the conscience of the many builders succumbs to the temptation. But the use of inferior materials and improper proportions is only one of the ways of scamping concrete construction. The time element is important also, and in any cases not sufficient time is given for the concrete to set before the forms are struck. Another serious defect found in some examples of reinforced concrete is the improper placing of the reinforcing rods. A steel reinforcement not properly placed may be worse than useless. It is too much to expect that ignorant laborers will place the reinforcement where it will act to the best advantage unless directed by competent overseers. Static loads are most favorable; vibratory loads test the quality of concrete as perhaps nothing else. Structures affected by the action of printing presses or other reciprocating machinery are likely to speedily deteriorate unless designed by experts and built of the best materials, properly mixed, skilfully placed, and firmly set before the forms are removed.

* * *

The habit of care is the best accident policy.

WELFARE WORK AT THE UTICA DROP-FORGE & TOOL CO.'S SHOP

The officials of the Utica Drop Forge & Tool Co., Utica, N. Y., have taken much pride in equipping their factory to make the working conditions the best possible for the employes. In many factories, grinding and polishing is a disagreeable and unhealthy operation, but by means of a complete and effective exhaust system in this plant, the polishing room has been put on a par with the other departments, as regards freedom from dust. The work is grinding and polishing pliers of all kinds, and a great deal of belt polishing is therefore necessary. As the illustration Fig. 1 shows, the belts and wheels are all enclosed and large size exhaust pipes draw away the dirt and dust from each wheel. Air required for the exhaust system is moved by a 30 H. P. Buffalo blower. The effect of the equipment is to make the polishing department a comparatively clean and sanitary part of the shop, and the workmen, far from being continually grimy, are, as a class, a remarkably clean and healthy looking lot of men.

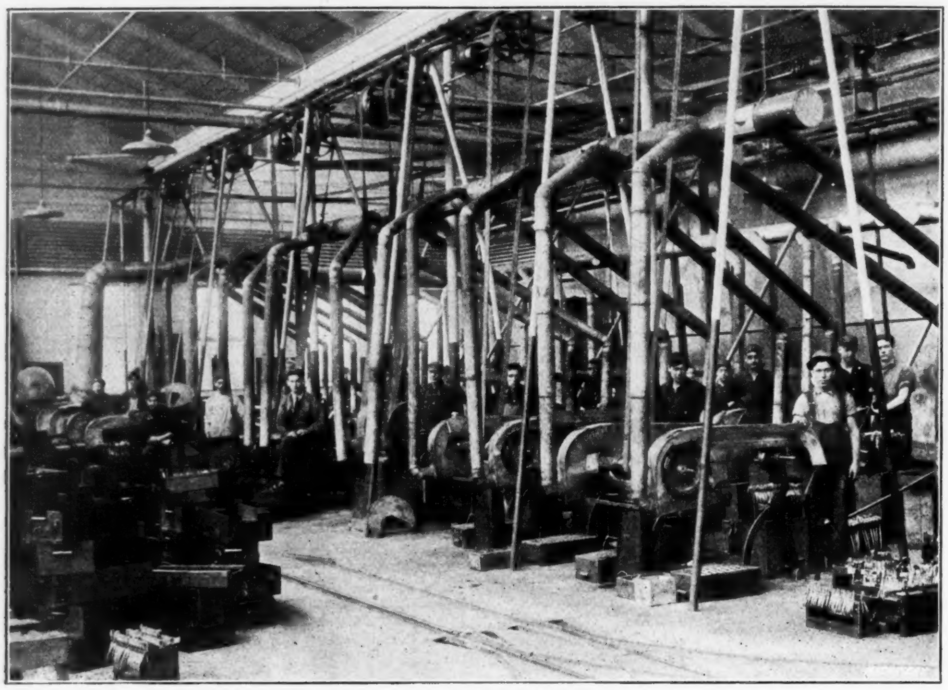


Fig. 1. A Dustless Grinding Room

For the convenience of the men in the drop-forging department, shower baths have been installed, each man being provided with an individual wash tray and shower bath. At the end of a hard day's work the men can clean up thoroughly before leaving the factory, being thus provided with conveniences which some perhaps do not have at home. In addition to the shower baths, a large wash-room is provided in which the 150 factory employes are provided with individual porcelain wash trays. Hot as well as cold water is available.

Fig. 2. Shower Baths for Employes in Drop-forging Department

Perhaps the most noteworthy example of welfare work is the special clubhouse building which was erected through the efforts of H. F. Kelleman, general manager. This two-story building is fitted with a bowling alley, rifle range, and game rooms on the first floor, and on the second floor, shown in

Fig. 3, a combined hall and gymnasium has been fitted up. In one corner of the hall is a pool table of standard make, and at the opposite end is a stage and piano. Entertainments given by the Mutual Benefit Association of the company are held in the hall from time to time, and at frequent intervals through the winter dances and gymnastic exhibitions are given. At all times outside of working hours, the building is open for the exclusive use of the employes, and they avail themselves of the opportunity every evening.

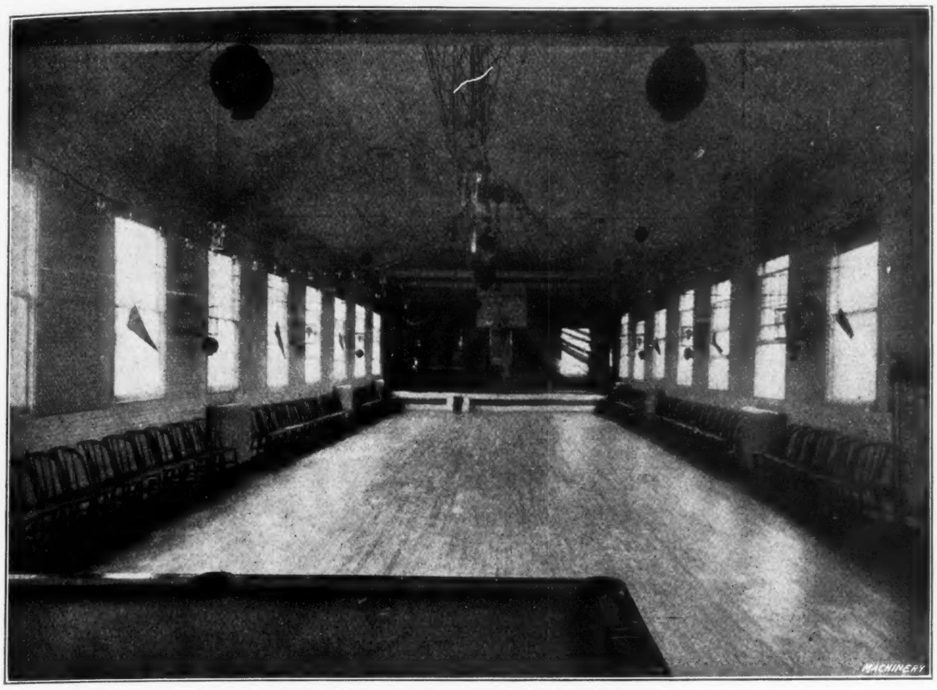


Fig. 3. The Recreation Hall in the Club-house

By means of welfare work of this kind, a spirit of factory pride is inculcated in the employes, which, coupled with the good working conditions afforded, enables the shop to attract and retain good workmen. C. L. L.

* * *

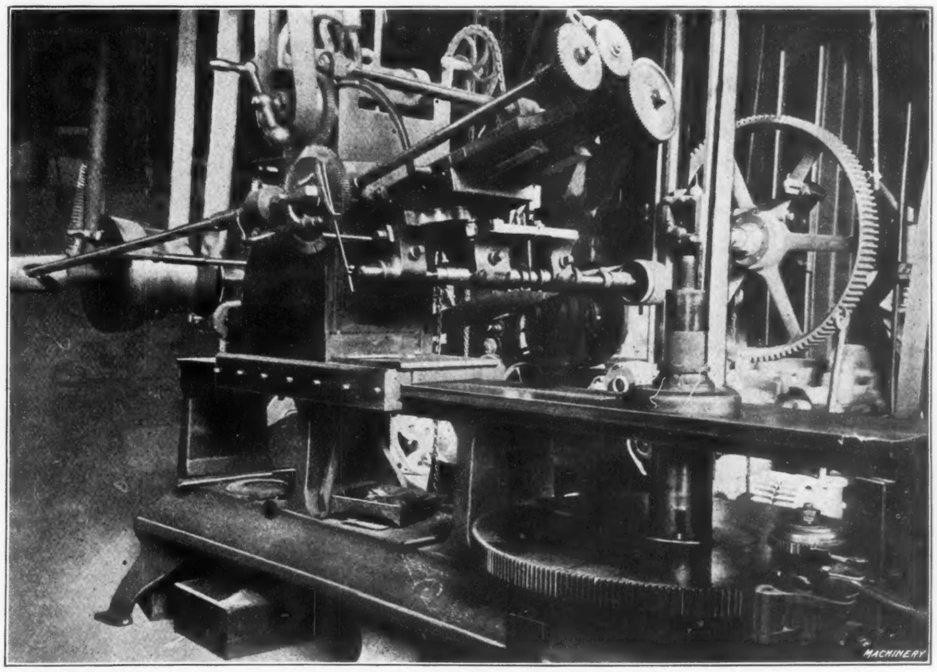
The file manufacturers of Sheffield, England, have displayed marked activity and enterprise in producing files of high efficiency, tested by means of recently developed methods for file testing. To an increasing extent users of files are now buying these tools on the basis of the amount of work they will do under given mechanical tests, instead of merely accepting the lowest tender. It is reported that at tests made by the Sheffield Testing Works, Ltd., a new type of fourteen-inch high-speed file, recently placed on the market by Messrs. Lockwood Bros., Ltd., of Sheffield, tested on both sides, made 120,000 strokes and in 39 hours removed 78.8 cubic inches of metal, weighing 22 pounds from a bar 1 inch square. At the conclusion of this severe test, the tool is reported to have been "slightly worn." The British Admiralty requires that files bought for naval use should make 20,000 strokes when tested and remove 6 cubic inches of material from a test bar 1 inch square. Recent improvements proposed both in Germany and England on file testing machines will be likely to still further enhance the value of these tests, and make possible an advance in the development of better files.

* * *

It is stated that an ordinary 16-inch disk fan contains more than 750 separate pieces of material and nearly 1400 feet of wire.

AN OLD GEAR CUTTING MACHINE

At the shops of the Rice, Barton & Fales Co., Worcester, Mass., there is an old gear-cutting machine which serves as a reminder of the progress which has been made in modern gear-cutting machinery. This machine was built by Lucius W. Pond of Worcester in 1872 and, as the illustration shows, was provided with a central work-spindle which held the gear blank in a horizontal plane. In referring to the illustration, the more modern gear-cutting machine in the background should not be confused with the old machine in the foreground. The machine is shown in position for cutting a bevel gear, the cutter spindle being mounted upon a hinged bracket so that angular cuts may be taken. When working on spur gears, the hinged bracket is elevated, of course, to an upright position, in contact with the head of the machine. The cutter-slide feed is operated by means of bevel gearing from the driving shaft, which may be seen toward the left of the illustration. By this means, motion is transmitted to the train of gears upon the end of the bracket on which the cutter-slide acts, which provides means for varying the rate of traverse of the cutter. Rotation of the cutter is effected by means of a pulley on the right-hand end of the cutter-spindle. While the machine is automatic in its cutting action, the gear blank must be indexed by hand. The indexing mechanism is shown in the lower right-hand corner of the illustration and consists of a large index gear having 240 teeth, and a pinion having 20 teeth which meshes with it. Thus it requires twelve revolutions of the pinion to carry the index wheel once around. The machine is supplied with several ratchets having different numbers of teeth which may be put onto the same stud as the pinion gear, for indexing the blank for different numbers of teeth.



A Gear Cutting Machine of Thirty Years ago

This machine is in active service to-day, being used for cutting bevel, spiral and spur gears. While it is not nearly as powerful a machine as the modern type, it is claimed to be fully as universal. The machine will cut spur gears up to ten feet diameter, with faces up to twelve inches width. C. L. L.

GETTING A RAISE

BY ROUNDERS

It has been estimated that there are twenty-seven million people in this great and glorious United States who hope to have their rates of pay raised during the coming year. It has been further estimated that they will not all get it. For years the magazines have been printing advice as to how to accomplish this very desirable result, and the great majority of it is good advice. It seems that a little supplementary advice about "what not to do in order to get a raise" might not come amiss. It is funny what a difference your position makes on how you look at things. For many years I worked zealously for raises and was of the opinion that a liberal policy of rewarding young men was very profitable. Then I got a job that depended on my keeping a payroll as small as possible and I at once decided that there was nothing in this raise idea anyhow. You see I was taken from the ranks and made a sort of straw boss, and the men that wanted a raise were told that this was up to me. Privately, I was told that no raises would be considered unless a corresponding saving could be made somewhere else, and that it was up to me to keep the force contented on what they were getting. Later on this policy was amended, and it was allowed that there might be occasions where a raise could slip through but that they would be mighty few and far between. In effect, I found that I had to either stand off my men or else go in to the big boss and beg for the raise. In place of simply working for my own raises, as I had done in other years, I was now obliged to be scheming all the time to get a little increase for such of the force as deserved it. I had no sooner gotten settled in my new job than I found that all my former associates were looking to me to get for them that increase that they felt they so richly deserved. One after another they buttonholed me, and I got so that I could tell for weeks ahead when some fellow or girl was working up courage to strike me. Some of them got what they were looking for and some did not. What I started to tell about was the time John Zeigler opened up his negotiation.

John was an old German draftsman and quite an "institution." He had been with the concern for many years, most of this time being taken up with asking his boss for an increase in salary. There had been several dozen bosses in this time, and none of them having John's experience some were bound to fall, so that the old fellow was getting the top notch figure that the concern would allow for the grade of position that he occupied. Being new to the job I was not fully posted as to salaries, although I knew in a general way that the old man was getting pretty close to the limit. Therefore, when he came to me with his tale of woe, I did not at once recollect what he was getting and I asked him casually, "What is your rate now, John?" He looked at me for a bit and then said, "Certainly you ought to know that."

He was right and I knew it. I should have known but I did not and in place of saying so and looking it up I said, "You are getting 'steen dollars a week are you not?" naming the highest figure that I thought was paid in the room. Now I missed it by five dollars a week, the old man getting that much more than I thought. In place of putting me straight, the old rascal assented and at once began to beg me to put through an increase card for five dollars more. Liars are never able to control their eyes, and there was something about the old fellow's manner that made me suspicious, so that I told him that I thought that perhaps I could get him a little increase but that I would have to see what the big boss thought about it. He thanked me and as soon as he had left I made a bee-line for the treasurer's office to see his rate and experience card myself. I found that he had deceived me, and after waiting a few days, I called him over and told him that I had gotten him a five dollar increase and that thereafter he would get 'steen dollars a week, naming the exact rate that he was then getting but five dollars more than he had led me to suppose. The old rapscallion thought that I had probably put through one of our regular cards authorizing the treasurer to jump him up five dollars more, that I would probably not discover that he had fooled me for some time and that I would then grin and bear the increase, the joke being on me.

I am satisfied that he fully expected to get five dollars more in his pay envelope and I watched him carefully as he opened it. He took it over to his table and ruminated on it a little. Finally he came over and asked me if he would get that raise the next week. I pretended great surprise. "Why, John," I said, "how much did you get? Let's see your envelope." The amount being written on the outside of the envelopes, it was an easy matter for me to check it up. He rather shamefacedly handed me the envelope and after I read the amount I handed it back to him with the remark, "That's right. That is the sum I told you you would get." The old fellow looked at me for awhile and then went back to his table and thought it over for a long time. This getting a five-dollar raise and still having no more in his pay envelope was a hard nut for him to crack, and I could see him wrestling with it. He finally gave it up as a bad job and I had no more trouble with him for some months. Neither of us ever admitted that we knew all about the reasons that lay back of this strange fact, and I do not know whether the old fellow ever appreciated the whole incident or not.

The funny part of the whole deal was that soon after I left the job he worked a very similar trick on my successor who after a long time confided it to me. I have often wondered since at the very opposite views taken of the incident by different people. The average employe thinks that his boss is wronging him by not promptly increasing his wages while, as a matter of fact, the chances are that this same boss is in a position where he cannot give such an increase and hold down his own job. I think those companies are happiest where the raise question is worked out logically, and a good man can count on a small yearly increase for a term of years. I also think that this increase should come naturally, and not depend on the solicitation of the man. Some fellows have a faculty of getting such increases while others, fully as valuable, are not good salesmen and go for long periods without getting what is coming to them.

* * *

WANTED, A HYDRAULIC ENGINEER

BY A. P. PRESS

One day we were sitting in the office after the rush of the day's work was over, when in came a long, gawky country boy, whose arms had a tendency to extend out of his sleeves, and whose pants did not grow as fast as his legs did.

"Say, Mister, is this where they fix things?"

"Why, yes, sometimes."

"Well, I've got something outside, and it wants fixing."

"What is it?"

"It's a water motor, but it don't mote."

Stepping outside the door, sure enough, there he had a good sized water motor, of a well known make and apparently new. It was about a two or three horsepower, with the usual pulley on one side, and the regular openings for the inlet and discharge of the water.

"Well, what's the trouble?"

"Why, I don't know. I sent and got that off the S. R. Co. and paid $36 for it, but when I took it home and put it down in the well it wouldn't go any."

"Put it down in the well! What in the world did you put it down there for?"

"Well, the circular says it should be at least twenty feet of water back of it, and the well is over thirty feet deep. I thought that ought to work pretty good."

"Yes, but don't you understand there is no power in still water?"

"Yes, Mister; but the book says I get a pound of pressure for every twenty-eight inches, only I don't just understand what that means."

To make a long story short we labored with the lad for an hour, and finally succeeded in demonstrating to him that the motor must be placed under a head of running water in order to develop any power, and then finally helped him out by giving him a small steam engine and boiler, and allowing him a fair price for his motor.

We have often seen a lack of mechanical knowledge, but never to a greater extent than in the case described.

PUNCH AND DIE MADE IN SECTIONS

BY A. L. MONRAD*

Among the interesting problems of tool design which the writer has dealt with, was a punch and die for producing the type bar plates for linotype machines, illustrated in Fig. 1. These plates have one hundred rectangular holes 0.060 by 0.360 inch in size; the bar is 0.03 inch thick. One of these plates is attached to the under side of each linotype machine for holding the end springs which return the type bars after the keys are struck by the operator. It is necessary to have these type bar plates made with considerable accuracy; the holes must be of the size specified, there must be the proper space between them, and their sides must be parallel and perpendicular, respectively, with the edges of the plate. Evidently these conditions would make it very difficult, if not impossible, to produce plates of this type with a single punch and die and some suitable form of spacing mechanism.

Several attempts were made to produce a punch and die for this purpose before a successful device was hit upon. In the first case, the punch and die appeared to be satisfactory after it was finished, but had only run a few days when one of the bridges caved in to such an extent that attempts to repair it were unsuccessful. The second punch and die was of similar design to the first, except that special means were taken to strengthen its construction. When this die was inspected after hardening, however, it was found that two of the bridges were cracked in the corners. It was then decided to make a sectional form of punch and die which would enable individual parts to be replaced when broken or worn in service, without necessitating the construction of an entirely new tool. The die section adopted for this purpose is indicated at *B* in Fig. 3. It will be seen that two 5/16-inch holes are drilled and reamed through these sections, pieces of drill rod being used to hold the sections together in a 30-degree bolster; the sections were wedged in this bolster by means of a suitable gib and set-screws. This die also proved a failure because no provision had been made for guide posts or pilots. The result of this omission caused the die to shift while in service, so that the punches were stripped to such an extent that they became absolutely useless. The difficulties met with in early forms of dies for producing these type bar plates are mentioned in order that the same trouble may be avoided by other shops that are called upon to produce punches and dies of this type for similar classes of work.

Fig. 1 represents the form of sectional die which was finally developed for this operation. All parts of this device which are likely to be worn or damaged in operation are made interchangeable, duplicate parts being kept in stock so that they can be placed in service when required. The die pieces are machined to the required dimensions, allowing 0.005 inch for grinding and lapping. One of the die sections *C* is shown in Fig. 3, and in machining these parts, in order that the slot will be the same distance from the inclined sides of the bolster, the milling fixture—also illustrated in Fig. 3—was designed for producing them. The cast-iron block of this fixture is held in an ordinary milling machine vise and the pins *E* and *F* are so placed that the blank for the die sections will be held at an angle of 60 degrees. The strap *G* holds the work in position while milling; all of the pieces are first milled at one end to an angle of 30 degrees, after which they are turned over in the fixture to have their opposite ends milled in a similar manner. Before starting the section milling operation, the machine is set to produce pieces of the required length, and it will be evident that this method of production insures having all the die sections of exactly the same size. The same fixture is used for milling the slot in the die section; for this purpose the fixture is swung around 30 degrees and a cutter 0.360 inch wide is used, the slot being cut 0.060 inch deep. The three sides of the slot are now relieved with a file and after being hardened and drawn at a light straw color, the sections are ground on both sides so that the section through the slot will just enter the 0.060 inch space in the gage *H*, and the thicker section will enter the 0.120 inch space. The bottom and angles are not ground, but the top of all the sections are ground when they are assembled in the cast-iron bolster *I*, Fig. 1. Two set-screws *J* are provided to take care of the end thrust on the die sections. The length of the die is 9 inches, but if it is found that this dimension is slightly exceeded, it is an easy matter to lap the sections off on the sides to reduce it the required amount.

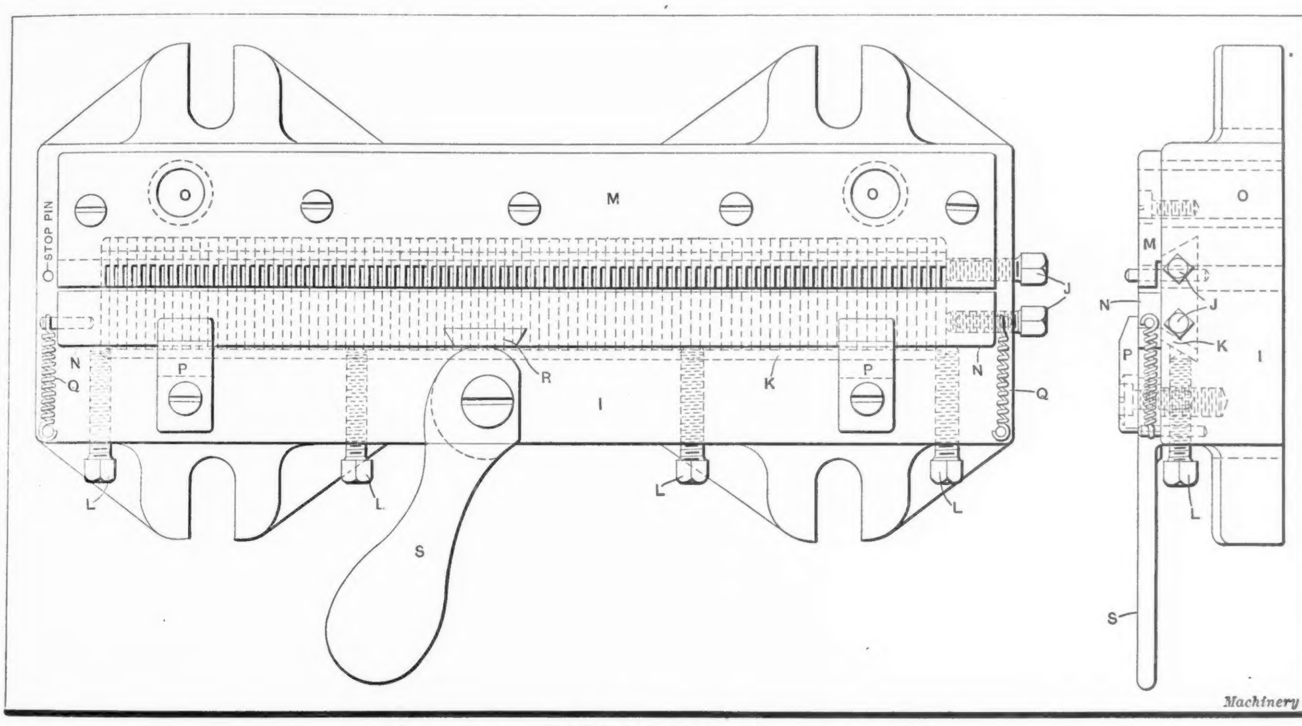


Fig. 1. Plan and End Elevation of Die made made in Sections

The cast-iron bolster is held securely to the press bed by means of four ⅝-inch hexagon screws. The gib *K* runs through the entire length of the die bolster and is held against the die sections by four set-screws *L*. On top of the bolster, there are two soft iron plates *M* and *N*. The plate *M* is held in position by five fillister screws and acts as a stop wall for the work to rest against in the die. This plate has slots milled along its edge which correspond with the die section, only they are a few thousandths larger than the punches; the plate *M* acts as the stripper for the punch. The plate *N* slides back and forth on the bolster under the strap *P*, its movement being controlled by the cam and lever *S*. The hardened wedge *R* is driven into the middle of the plate for the cam *S* to rest against and when the cam is swung around to bring the flat

* Address: Rockfall, Conn.

section into engagement, the springs Q at each end of the die pull the plate N back so that sufficient space is made to lift the finished work out of the die.

There are two ¾-inch holes O provided in the bolster to receive the pilots B of the punch-holder, Fig. 2; these holes have hardened bushings driven into them which can be replaced when they become worn to an objectionable extent. The punch sections are held in a machinery steel holder A shown in Fig. 2. This holder is finished all over, great care being taken to secure the necessary alignment. The guide pins B are hardened, ground and lapped to exact dimensions

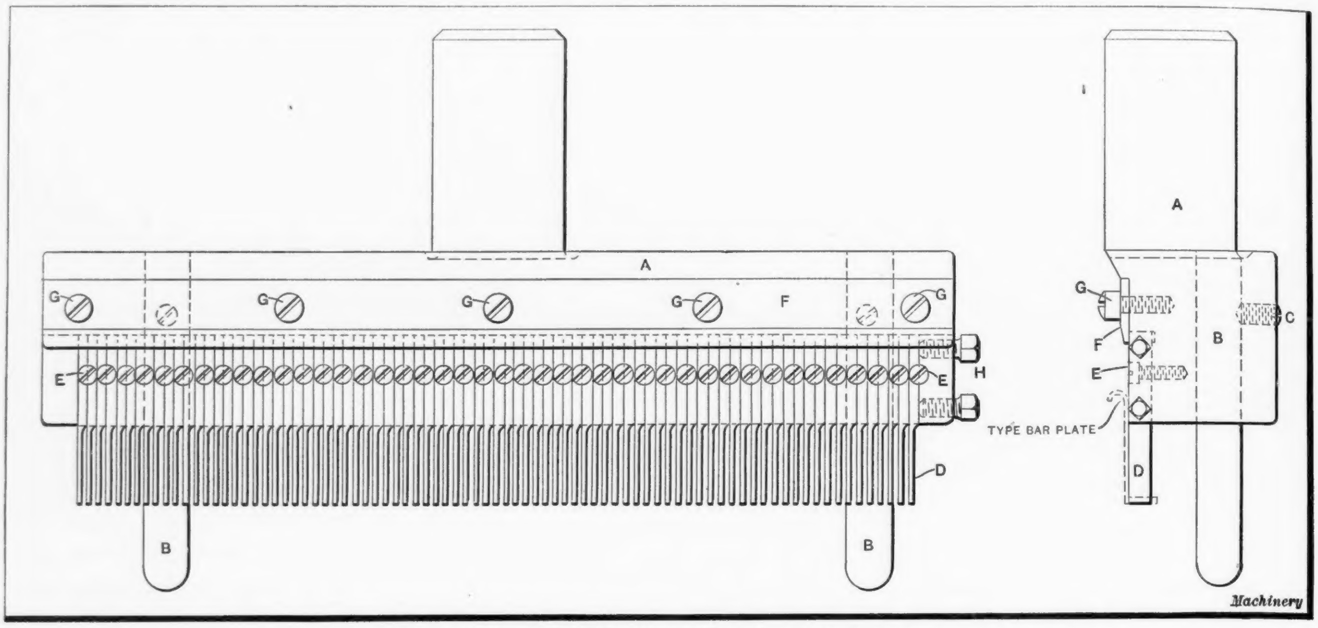


Fig. 2. Side and End Elevations of Punch made in Sections

and the same gage H that was used for measuring the die sections is also used in determining the accuracy of the punch sections. These punch sections are secured to the holder by fillister screws E, a single screw being used between two sections in the manner shown in the illustration. The clamp F runs the entire length of the holder and is held in position by the fillister screws G; this clamp member holds the clamp securely in position. Two set-screws H are provided to take up any end thrust in the punch sections.

It may appear that this punch and die is rather elaborate, but this design seemed to be the only means of producing a device that could be maintained in working condition, and as a matter of fact, the working parts are relatively simple, and were not as expensive to make as it might appear. The forming of the type bar plates A is done in two operations. The stock is rolled on a spool and held in the proper position

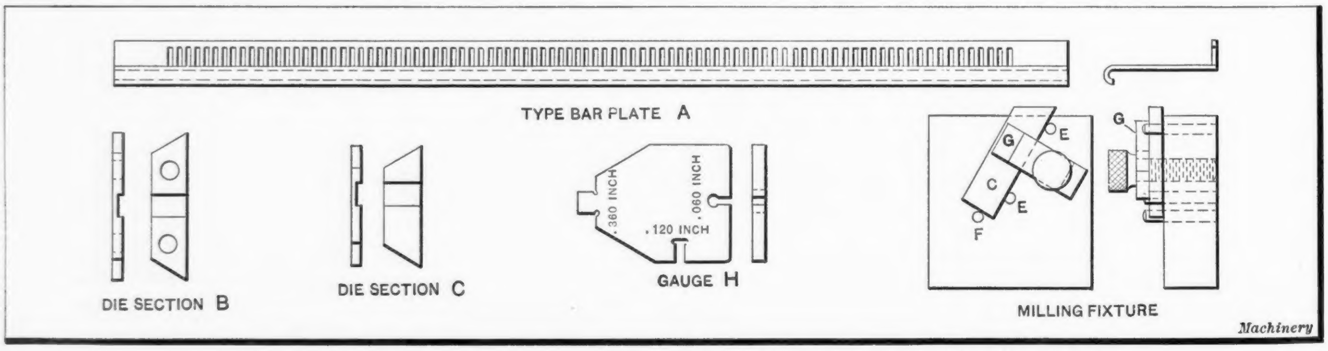


Fig. 3. Type Bar Plate A, Die Sections B and C, Gage H, and Milling Fixture for making Die Sections

to be received by a powerful trimming press. In the first operation, the stock is cut off and formed to the right angle; the downward stroke of a roller at the back of the die then curves the other edge of the plate upward to form a quarter segment. The second operation is made separately in a clamping die and forms the plate to the required shape.

* * *

The shipbuilding tonnage during 1912 for the United Kingdom is the greatest on record, the total output being more than 2,125,000 tons.

WHEELS FOR TRUCKS IN MANUFACTURING PLANTS

Metal tired truck wheels are generally used in manufacturing plants, notwithstanding the increased wear of floors as compared with that incident to the use of soft tire wheels. The president of the Aberthaw Construction Co., Boston, Mass., who has investigated many features of factory management, states that the preference is due particularly to the greater resistance of soft tire wheels as compared with metal tire wheels. There is again, the trouble of keeping soft tire wheels in proper condition as well as the expense. The fact is pointed out that there are wheels made with fiber tires, wheels made with sheets of fiber bolted together, and wooden wheels made in various forms. A wheel of hard wood cut into sectors with the sections breaking joints, makes an entirely satisfactory wheel for heavy loads, and one that is particularly good under wet conditions. Trucks equipped witn fiber or wood wheels operate as easily as trucks with metal wheels and are much easier on the floors. This is an important consideration in all manufacturing plants where large amounts of material are moved from station to station on trucks.

* * *

The popularity of the American automobile is evidenced by the fact that the exports of automobiles and parts thereof, including tires, approximates $30,000,000 in 1912, against $22,000,000 in 1911, $15,000,000 in 1910, and $9,000,000 in 1909. A striking fact shown by the automobile figures is the marked decline in the price at which the machines are exported. In 1907 the average export price was nearly $1800 per machine; in 1909, $1470; in 1911 about $1000; and in 1912, a little less than $1000 each, the average export price at the present time being thus but little more than one-half that of 1907. The automobiles exported are sold chiefly in British territory. Of the 21,707 machines exported in the eleven months ending November 6, 864 went to Canada, 4371 to the United Kingdom, and 3112 to British Oceania.

TURNING AND FORMING CLUSTER GEARS

BY HENRY M. WOOD*

The accompanying illustrations show the lathe work in turning and forming cluster gears in the shops of the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio. Fig. 1 shows a 24-inch patent head lathe equipped with multiple stops for length and cross feeds, connected compound and plain rests, pan, pump, and tubing, performing this operation. As the multiple stops and connected compound and plain rests have previously been described in detail in MACHINERY, it is unnecessary to enter into a further description here. The blank stock before being delivered to the lathe is bored and counterbored as indicated in Fig. 2. The broken lines indicate the size of the blank when it is first delivered to the lathe, *i. e.*, a straight bar 5 3/8 inches in diameter by 7 3/16 inches long. The solid lines show the finished dimensions except that the gear teeth, which are cut in a subsequent operation, are not shown, the illustration being prepared merely to indicate the lathe work that is done. Fig. 3 is a plan view showing the tooling for this work.

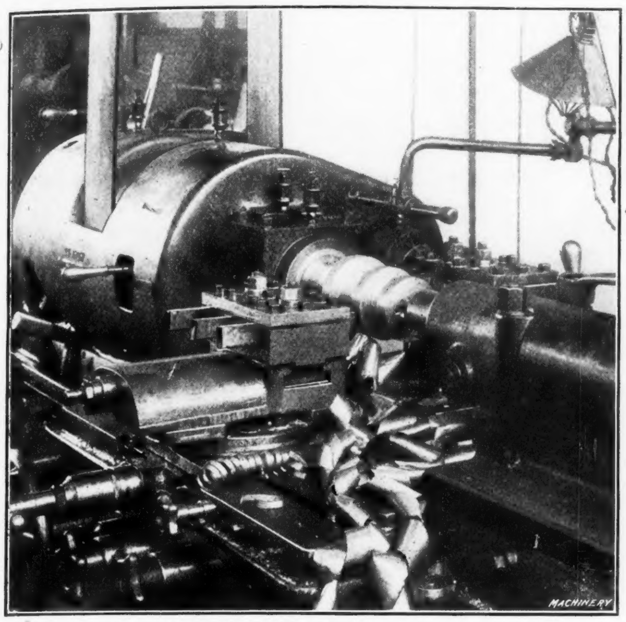


Fig. 1. Lodge & Shipley Patent Head Lathe turning and forming Blanks for Cluster Gears

A special arbor is used for carrying the blank. This arbor has a shoulder at the head end of the lathe to correspond to the counterbored part of the gear blank. There is a key in the arbor to act as the driver. The blank is slipped onto the arbor and forced up against this shoulder. This always insures that each blank placed in the lathe will take the same longitudinal position as all of the others, and therefore the shoulder positions for all gears, as determined by the automatic length feed stops, will come out exactly the same. A portion of the work is done by wide forming tools, and, as seen in Fig. 1, two heavy forming cuts are taken at the same time. This produces more pressure against the work than could safely be supported by the tailstock center. Therefore, the tailstock center is removed, a bronze bushing placed inside the tailstock spindle, and the free end of the arbor made a nice running fit in this bushing. Before turning operations are commenced, the tailstock spindle is run out so that the bushing solidly supports the end of the arbor.

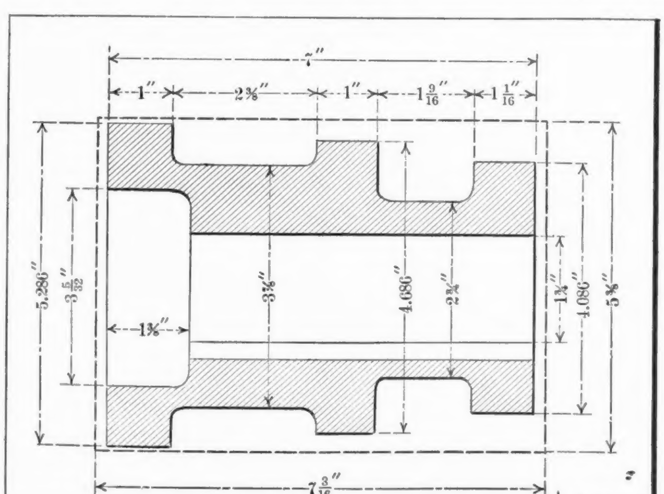


Fig. 2. One of the Blanks bored and counterbored ready for the Lathe Operation

First Operation. The outside diameters of the gears are first roughed by the three turning tools carried in a gang in a special holder held in the compound rest at the front. The cross-feed slide is fed in until the proper point is reached, as determined by the cross-feed stop which has previously been set to give a roughing cut 1/32 inch over size. The power feed is engaged and the three tools continue in action until each has fed across the face of the gear it is turning; at that point the length feed stop trips.

Second Operation. The operator leaves the carriage in the position thus determined by the length feed stop and draws the cross-slide forward, which brings the rear tools into action. The rear tools are also arranged in a gang, and consist of two facing tools for the ends of the blanks and two forming tools for cutting the spaces between the gears. At one operation the forming tools rough out and finish to the proper diameter; they also finish the faces and sides of the gears with the same movement of the cross-slide.

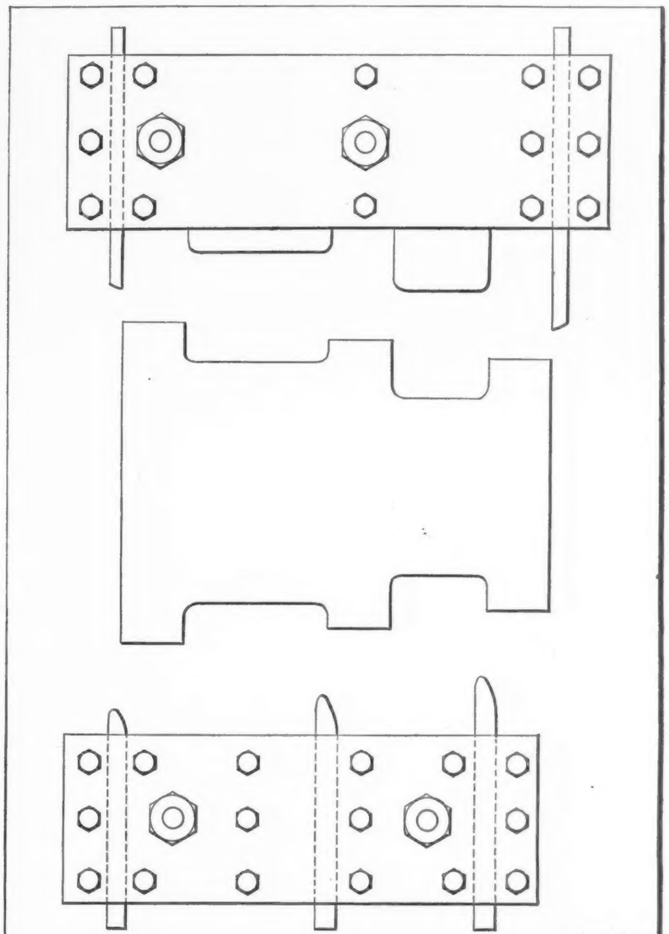


Fig. 3. Diagram showing Tooling for turning and forming Blanks for Cluster Gears

Third Operation. The carriage is returned to its original position. The diameter stop bar is changed to bring another stop into line and the cross-slide is again fed forward to this second stop which locates the three turning tools in the proper position to give the exact finished outside diameters of the three gears. One cut is then taken across the work and the job is done.

The material used for these blanks is chrome-nickel steel with about 0.25 carbon. The blank when delivered to the lathe weighs 38 pounds. The cluster gear after the lathe work is completed weighs 18¼ pounds. The machining time for the

* Address: Lodge & Shipley Machine Tool Co., Cincinnati, Ohio.

lathe work mentioned—including turning, forming and facing —is twelve minutes for one blank, exclusive of the time occupied in setting up or handling. This exceptional output is made possible by a combination of the power of the patent head lathe, the time saving features of the multiple stops and connected rests, and the special tooling for this particular job.

* * *

TAP FLUTING CUTTERS

BY CORRESPONDENT

The question of the proper shape of flutes for taps to produce the best form of cutting edges or teeth, mentioned in an editorial in the January number of MACHINERY, has always been a difficult problem to toolmakers and tool manufacturers. Of all small machinists' tools, no one class presents so many interesting points and so many difficulties regarding the rake, chip rooms, etc., as do taps, and the opinions regarding the proper shape of flutes vary to a great extent. It is evident that taps used in different ways and for different purposes should have different forms of cutting edges, and that, in most cases, the same kind of tap should have differently formed cutting edges when cutting materials of different composition. It is, however, necessary for the tap manufacturer to make taps with cutting edges and flutes of such a shape as to satisfactorily tap as many different kinds of materials as possible with the same tool, because tap users, in general, cannot afford, nor can they be induced, to buy taps of the same size with differently shaped flutes for different materials. Hence, it is necessary to determine which form of fluting cutter will produce the best all-around results. In the following will be shown a type of fluting cutter which has been found to be far superior for all-around work to any that have previously been described.

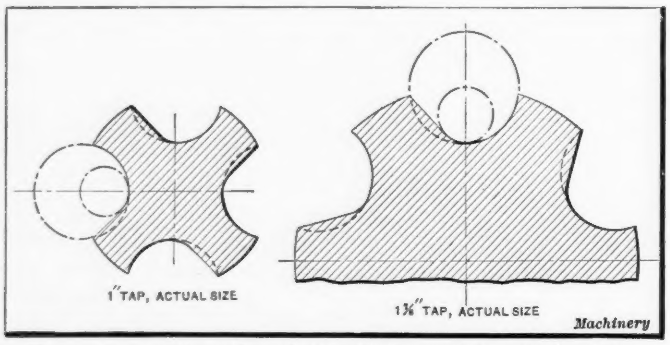


Fig. 1. Cross-section of Taps fluted with Proposed Type Fluting Cutter

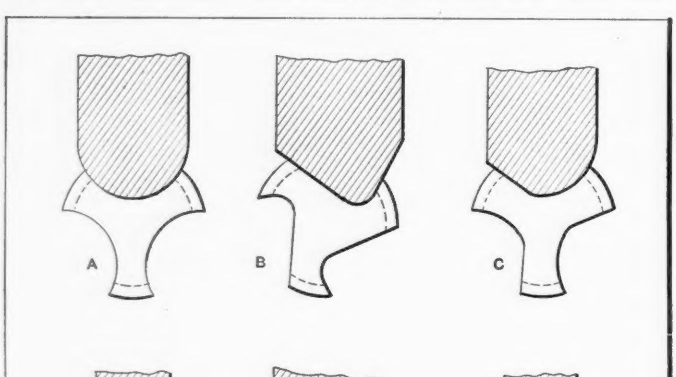


Fig. 2. Three-quarter inch Diameter Tap fluted with Three and Four Flutes using Different Style of Fluting Cutters—Actual Size

The most universally used cutter for fluting taps is undoubtedly the so-called convex fluting cutter, tables for which were given in MACHINERY, October, 1911. It has been generally accepted that when taps have to be backed out of a hole, the convex cutter is the best one to use for fluting them, because, on account of the form of the flute, the chips are not liable to get in between the teeth of the tap and the threads in the nut when backing out. A critical study, however, will lead to the conclusion that while the hook or undercut produced on the cutting edges of the tap by the convex-shaped fluting cutter is an advantage on taps for general all-around use, there is no reason for having this hook or undercut on the back side of the cutting land of the tap. When a tap is fluted by a convex fluting cutter, therefore, instead of by one that would give what might be termed a slight negative rake to the back side of the land, the tap is not only seriously weakened, but whenever it has to be backed out of a hole, as do hand taps, in many cases, and screw machine taps, in all cases, it is liable to cut and scrape the thread in the tapped hole on the return.

Cutters of the shape shown in the illustration in Table I, for taps from 1/16 to 4 inches in diameter, produce the same amount of undercut or hook on the cutting land of the taps as do the convex cutters, but the back of the cutting lands has a slight negative rake, smaller, however, than that produced by the regular old-style fluting cutter with an 85-degree included angle between the straight sides of the teeth, described in MACHINERY, June 1907. The shape of the cutter is such that all danger of chips getting in between the threads of the tap and the threads of the tapped nut, when the former is backed out, is practically eliminated. The strength of the tap has been increased without in any way sacrificing any of the advantages gained by the use of the convex fluting cutter. In the illustration accompanying Table II, two of the flutes have been shown as shaped with a regular convex cutter, while the others are laid out as cut by the proposed cutter. In Fig. 1 are shown 1- and 1-⅞-inch taps drawn accurately to scale—actual size. The dotted lines show the shape of the flute if cut by a regular convex cutter, showing clearly the advantages of the proposed type.

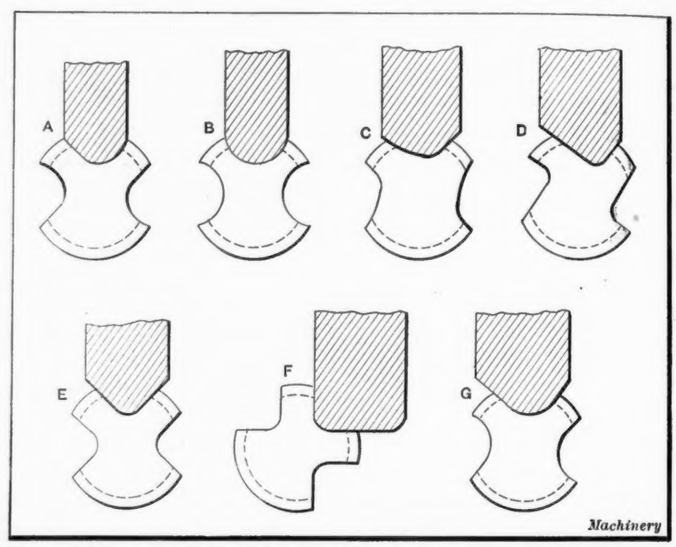


Fig. 3. Comparison of Methods and Cutters for Tap Fluting

The thickness of these cutters, as given in Table I, is the minimum thickness. They should preferably be slightly thicker than the figures given, the additional thickness being added on the angular side. The depth of the flute is governed by the rule that the width of the land at the top of the thread should be as nearly as possible equal to one-half of the width of the space, or, in other words, for four-fluted taps, the width of the land should be one-twelfth of the circumference of the tap, and for six-fluted taps, the width should be one-eighteenth of the circumference. The table of fluting cutters gives the outside diameter and the diameter of the hole in the cutter also, but these dimensions are, of course, optional and are given only as a guidance. In Figs. 2 and 3 are shown a comparison between the flutes produced with different kinds of fluting cutters, cutting three and four flutes in taps. At *A*, *B* and *C*, in Fig. 2, are shown taps with three flutes, and at *D*, *E* and *F*, are shown taps with four flutes. *A* and *D* show a regular convex fluting cutter for cutting the flutes; *B* and *E* show a double angle cutter—85 degrees included angle, 30 degrees on one side and 55 degrees on the other; *C* and *F* show the pro-

posed style of fluting cutter. In Fig. 3 is shown a comparison between methods and types of cutters that are or could be used for fluting taps. At *A* is shown the new-style cutter; at *B*, the regular convex cutter; at *C* and *D*, cutters of the shape shown in the Brown & Sharpe Mfg. Co.'s catalogue; at *E*, a double-angle cutter of 90 degrees included angle, 45 degrees on each side; at *F* is shown a regular side milling cutter used for fluting taps; and at *G*, the 85-degree included angle fluting cutter with a very large radius for the arc connecting the two straight sides.

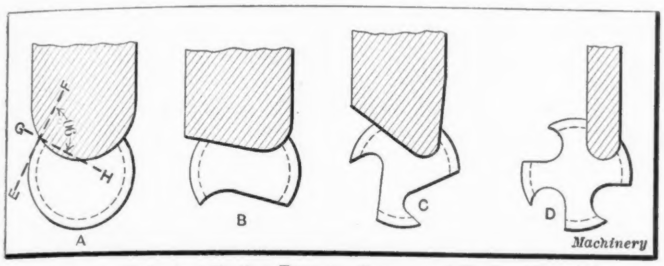
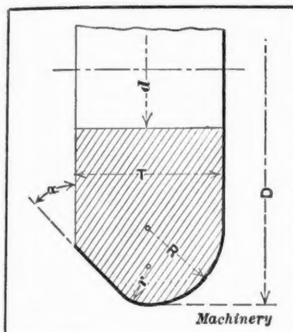


Fig. 4. Method of Fluting Taps for Copper and Similar Materials

In order to compare the differences between the flutes cut with a convex milling cutter and one cut by the new proposed style of fluting cutter, Table II has been made up, giving the thickness of the land *A* measured at the weakest part of the land, when cut with a convex cutter, and the thickness of the land *B* measured at exactly the same point, when the tap is fluted with a new-style cutter. It also gives the difference *C*, which is a measure of the increased strength in the tap produced by the new-style cutter. It is likely that cutters of the type described will eventually be generally used for tap manufacture and adopted by tap makers in general, as there is no doubt that this style of fluting cutter is superior to the cutters now generally employed.

TABLE I. DIMENSIONS OF TAP FLUTING CUTTERS



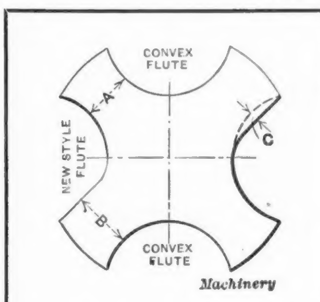
Number of Flutes, Angles and Diameters of Cutters				
Size of Taps, Inches	No. of Flutes	Angle α, Degrees	Diam. of Cutter D	Diam. of Hole d
1/16 to 1/8	3	60	1 3/4	3/4
5/32 to 11/16	4	45	1 3/4	3/4
3/4 to 15/16	4	45	2 1/4	1
1 to 1 3/4	4	45	2 1/2	1
1 7/8 to 4	6	40	2 1/2	1

Diam. of Tap	Large Radius R	Small Radius r	Thickness T	Diam. of Tap	Large Radius R	Small Radius r	Thickness T
1/16	0.023	0.010	0.047	1 7/16	23/64	11/64	23/32
3/32	0.035	0.015	0.070	1 1/2	3/8	3/16	3/4
1/8	0.046	1/64	3/32	1 9/16	25/64	3/16	25/32
5/32	0.039	1/64	5/64	1 5/8	13/32	13/64	13/16
3/16	3/64	1/64	3/32	1 11/16	27/64	13/64	27/32
1/4	1/16	1/32	1/8	1 3/4	7/16	7/32	7/8
5/16	5/64	1/32	5/32	1 7/8	0.322	15/64	0.644
3/8	3/32	3/64	3/16	2	0.344	1/4	0.687
7/16	7/64	3/64	7/32	2 1/8	0.365	17/64	0.730
1/2	1/8	1/16	1/4	2 1/4	0.387	9/32	0.773
9/16	9/64	1/16	9/32	2 3/8	0.408	19/64	0.816
5/8	5/32	5/64	5/16	2 1/2	0.430	5/16	0.879
11/16	11/64	5/64	11/32	2 5/8	0.451	21/64	0.902
3/4	3/16	3/32	3/8	2 3/4	0.473	11/32	0.945
13/16	13/64	3/32	13/32	2 7/8	0.494	23/64	0.988
7/8	7/32	7/64	7/16	3	0.516	3/8	1.031
15/16	15/64	7/64	15/32	3 1/8	0.537	25/64	1.074
1	1/4	1/8	1/2	3 1/4	0.558	13/32	1.117
1 1/16	17/64	1/8	17/32	3 3/8	0.580	27/64	1.160
1 1/8	9/32	9/64	9/16	3 1/2	0.601	7/16	1.203
1 3/16	19/64	9/64	19/32	3 5/8	0.623	29/64	1.246
1 1/4	5/16	5/32	5/8	3 3/4	0.644	15/32	1.289
1 5/16	21/64	5/32	21/32	3 7/8	0.666	31/64	1.332
1 3/8	11/32	11/64	11/16	4	0.687	1/2	1.375

Taps for Materials Other than Steel

Ordinary commercial taps are not suitable for cutting material of a tenacious nature, such as copper, fiber, etc. Taps for cutting copper and materials of a similar composition should have the back face of the lands of the taps at right angles to the thread, as shown by lines *EF* and *GH* in Fig. 4. It will be seen that a cutter made along the lines just outlined will be more suitable for obtaining this condition than the convex fluting cutter. The most generally used cutter for fluting taps for copper is probably that shown at *A*, in Fig. 4, where a convex cutter is used for fluting the tap, the latter having but one flute, so as to leave as much bearing surface as possible between the tap and the threads in the nut, to prevent the tap from tearing the thread during the tapping operation. Taps of this kind should not be relieved in the angle of the thread, especially not by means of a file, which leaves the relieved portion rather rough and increases the liability of the chips sticking and clogging between the threads of the tap. At *B*, *C* and *D*, Fig. 4 are shown other forms of flutes which are quite frequently used for taps intended for tapping copper. All taps for materials of this kind should be reversed frequently during the tapping operation in order to avoid damage to the threads being cut as far as possible.

TABLE II. COMPARISON BETWEEN OLD AND PROPOSED STYLE OF FLUTES



Size of Tap	A Inches	B Inches	C Inches
1/16	0.017	0.024	0.007
3/32	0.027	0.037	0.010
1/8	0.035	0.049	0.014
5/32	0.032	0.037	0.005
3/16	0.039	0.045	0.006
1/4	0.052	0.060	0.008
5/16	0.065	0.075	0.010
3/8	0.078	0.090	0.012
7/16	0.090	0.105	0.015
1/2	0.103	0.120	0.017
9/16	0.116	0.135	0.019
5/8	0.129	0.150	0.021
11/16	0.142	0.165	0.023
3/4	0.155	0.180	0.025
13/16	0.168	0.195	0.027
7/8	0.181	0.210	0.029
15/16	0.194	0.225	0.031
1	0.207	0.240	0.033
1 1/16	0.220	0.256	0.036
1 1/8	0.223	0.271	0.038
1 3/16	0.246	0.286	0.040
1 1/4	0.259	0.301	0.042
1 5/16	0.272	0.316	0.044
1 3/8	0.285	0.331	0.046
1 7/16	0.298	0.346	0.048
1 1/2	0.311	0.361	0.050
1 9/16	0.324	0.376	0.052
1 5/8	0.337	0.391	0.054
1 11/16	0.349	0.406	0.057
1 3/4	0.362	0.421	0.059
1 7/8	0.293	0.336	0.043
2	0.312	0.358	0.046
2 1/8	0.332	0.381	0.049
2 1/4	0.352	0.404	0.052
2 3/8	0.371	0.426	0.055
2 1/2	0.391	0.449	0.058
2 5/8	0.410	0.470	0.060
2 3/4	0.430	0.453	0.063
2 7/8	0.449	0.515	0.066
3	0.469	0.538	0.069
3 1/8	0.488	0.560	0.072
3 1/4	0.508	0.583	0.075
3 3/8	0.527	0.605	0.078
3 1/2	0.547	0.628	0.081
3 5/8	0.566	0.649	0.083
3 3/4	0.586	0.672	0.086
3 7/8	0.605	0.694	0.089
4	0.625	0.717	0.092

* * *

A fire protection committee appointed last spring, by the New England Foundrymen's Association, has analyzed the status of the membership of the association with regard to fire hazards, fire-fighting apparatus, and insurance rates. Of course, the latter are made the basis of very sweeping conclusions with regard to their relation to the former. It has been shown, for instance, that in thirty-two properties protected by automatic sprinklers, the insurance rate averages 10.5 cents per $100 at risk, including all types of construction and other hazard. As compared with this, the rate on foundries constructed of brick and concrete but without sprinklers was 96.5 cents, or more than nine times as much. Buildings constructed partly of brick and partly of wood show an average rate of $1.31 per $100 at risk. Similarly, wooden buildings without sprinkler protection have an average rate of $1.87, or almost two per cent. The committee recognizes that the mere question of insurance savings is quite subsidiary. The fact that a single crippling fire might mean loss of business for months, carrying with it the loss of established trade and seriously hampering other departments of a large establishment, must always far overshadow any question of insurance premiums.

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

MARCH, 1913

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IS A NEW MACHINE NOMENCLATURE NEEDED?

The National Machine Tool Builders' Association, through some of its active members, is carrying on a propaganda in favor of changing many of the well-worn machine terms to names more definite and not so likely to be misunderstood. Some names undoubtedly need changing. A "drill" for instance, may mean either the machine or the cutting tool used for making a hole. Obviously "drill" should mean the actual cutting tool, and "drilling machine" the machine driving the "drill" and supporting the work.

The indefinite meaning of "machine tools" affected the industry seriously when the Underwood tariff bill was framed, because the term was supposed by the framers to mean the cutting tools only, such as drills, reamers, counterbores, mandrels, arbors, taps, dies, lathe and planer tools, etc., but it is generally understood by those familiar with the equipment of shops, to mean the machines used in the metal-working industry for turning, drilling, planing, milling, boring, slotting, shaping, sawing, profiling, etc.

The National Machine Tool Builders' Association and the journals devoted to the machine tool trade can in time effect a change in the usage of terms that are obviously misleading or erroneous; but we doubt the wisdom of changing the honorable word "lathe" to "turning machine." We believe it would be wiser to limit the changes at first to those names that now cause confusion and mistakes.

* * *

THE TRUE MEASURE OF INCREASED EFFICIENCY

Frequently statements intended to indicate the increased efficiency of a new machine or method are made in the following words: "It used to take us fifteen minutes to make this piece, but with this machine we turn it out in seven minutes." The unsuspecting listener to this outburst of enthusiasm is easily led to believe that the new machine makes it possible to produce at one-half the cost, as compared with the previous method, but this is by no means a foregone conclusion. The new machine may cost a great deal more than the old one, the overhead expense may be greater, repairs may be more frequently required and the cost of repair parts higher. All these items must be taken into account before a true comparison between the efficiency of the two machines can be made.

The only comparison of the efficiency of two machines or methods that has any value should be made as follows: "The cost of producing one piece by the old method, counting all overhead expense—interest, depreciation, cost of repairs, etc.—was 39 cents. Taking into consideration the same items of expense, the cost of producing one piece by the new method is 31 cents." This gives a true comparison of the relative value of the two methods. It is possible that when the piece is made for 31 cents, it requires but one-quarter of the time as compared with a piece made by the method which costs 39 cents, but in the latter case only the very cheapest machinery was employed, whereas the new method makes use of costly appliances. Comparisons of this kind, therefore, to be of any value, must take into account all the factors of expense—not the labor cost alone.

* * *

LOW COSTS FROM HIGH-GRADE METHODS

The idea has by no means been dispelled that high-grade productions are necessarily high-priced. Whether or not high-grade work is costly depends largely on the quantity produced. If the quantity made is small, high-grade work will generally cost more than low-grade work, but if the quantity made is large enough to warrant the installation of first-class machines, tools and methods, the cost of production may be reduced to less than that of a low-grade product made by out-of-date machines and methods.

The manufacturer of a new firearm which probably will be widely sold was asked if he would improve the equipment of his plant in order to increase his output. He replied that his company would use improved machines and methods as much as it could afford, considering the low cost of the product! As a matter of fact he needs better machines and methods more imperatively than if the product were sold at a higher price. He simply cannot afford to use any but the very best methods and machines if he is to get all the profit possible.

Modern methods may sometimes increase the production of parts on which great accuracy or high finish is not required, such as the crankshafts of a certain agricultural machine which ordinarily are long slender malleable iron castings, rather difficult and costly to make, even though left rough as they come from the foundry. When made from steel shafting, bent to the multiple-throw shape, and ground on the bearings by modern grinding machines, the finish and accuracy of the product are greatly improved, and the cost much reduced. Ground bearings are not necessary, but the grinding method produces a superlatively good crankshaft at a lower cost than the old way. Now the fact that ground bearings are unnecessary on a rough agricultural machine is no reason why the progressive manager should refuse to employ the process. It is true he gets better work than is needed, but he gets it at so low a price that other common methods are at a disadvantage. In such cases it is cheaper to do the work well than to do it poorly.

* * *

The ignorance of some public men of the industries in their home cities might be taken as an indication of the superficial knowledge possessed by many supposedly intelligent public men of those things that are the bases of prosperity or the mainsprings of progress. It is claimed that a member of Congress whose home is in a large Eastern city noted for its machine tool industry—a lawyer of considerable ability—confessed that he knew nothing whatever about the machine tool business nor what machine tools were. He did not know that the Underwood bill vitally affected one of the big businesses in his own city. This lawyer member of Congress, of course, was inexcusably ignorant, but are not the machine tool builders themselves somewhat to blame for not pushing themselves into greater prominence? When it is considered that machine tools are the fundamental machines on which the production of all other machines is dependent, there certainly seems to be some ground for claiming a greater share of recognition in a country noted for its mechanical development.

THEORY VS. PRACTICE

The very title of this editorial is a paradox, but how often do we see theory and practice referred to in this manner. The right way would be to say "Theory and Practice"—not "Theory versus Practice." If theory and practice appear to disagree, either the theory or the practice is wrong, for when rightly applied, theory goes hand in hand with practice everywhere. There is no shop operation so simple that it does not in some way involve the application of a theoretical principle. There is no designer or mechanical engineer, no matter how highly educated, who can successfully design the simplest device without taking into account some practical requirement. The man who looks upon theory as an abstract matter, useless in his practical work, merely proclaims his ignorance. The man who prizes theory so highly that he believes he can afford to disregard the practical requirements and leave them to the shop man to decide, thinking that it is below his own dignity to bother with such details, paves the way for inefficiency and confusion. One of the reasons that America has excelled in the art of machine building is that our practical shop men have had more "theory" than the average European working men, and that our engineers and designers have had more practical training than the technical leaders on the other side. Let it be reiterated that practice without theory is almost as useless as theory without practice, and that there is no such thing as "theory versus practice"; it is "theory and practice" that achieves results.

* * *

AUTOMOBILE MANUFACTURING ORGANIZATIONS

The growth of the automobile manufacturing industry in America has been too rapid to permit some of the large concerns to organize on efficient lines, especially as regards the purchasing of equipment and getting the best results from it in the factory. For instance, special machinery for making certain shapes requiring exactness is purchased, and unsatisfactory work is produced. The foreman condemns the machine as worthless, stating that it will not produce the required product, notwithstanding the fact that he has samples of work produced on the machine before shipment which fulfill the requirements in every respect.

Here is a situation difficult to handle. The machine tool builder knows that the foreman of that department is either ignorant or incompetent, but he cannot afford to antagonize him or "show him up" to his superintendent. He must personally investigate the trouble and recommend as delicately as possible that certain changes in method be made to correct it. In a case that came to our attention recently, a machine was condemned because of the fact that certain formers specified to be used on it were not used, but others several inches smaller in diameter were substituted, the result being, of course, that the work was not up to the required standard. The machine tool builder was not to blame for the blunder, but his prestige suffered, nevertheless.

The organization of every manufacturing plant should be headed by men who have common sense as well as expert knowledge. Such men would know that machine tool builders having years of established reputation do not put special machinery on the market that is fundamentally wrong in design. When a complaint comes from a department that satisfactory results cannot be produced on a new machine, the conditions should be carefully examined to discover, if possible, what the trouble is. Weak spots in the organization can be discovered under such circumstances that might remain hidden otherwise. "Look for trouble at home before blaming someone outside" is a good rule for the progressive manager to follow.

* * *

When a foreman wants a certain kind of a machine for his department and gets another, one must remember that he is only human and that it is possible that he will not get all out of the new machine that might be expected. Of course, there are foremen and foremen, and the one that gets the most out of the machine that he does not believe meets his requirements is a mighty good one.

THE DESIGN OF PIT HEAD PULLEYS

BY JOHN S. WATTS*

The pulley used to carry the rope that hoists the cage in a mine shaft, is evidently a very important part of the machinery, as failure of this pulley would probably lead to dropping the cage. In spite of this fact, many engineers do not know how to calculate the safe load for such a pulley, and so far as the writer knows, there are not any formulas given in the engineering hand-books to cover this design. The method presented herewith has been found a satisfactory means of estimating the load that a rope pulley will safely carry.

Fig. 1 shows a common type of pit head pulley with wrought-iron spokes. The method of casting this pulley consists of setting the spokes—which have previously been polished on the ends where they enter the casting—in their proper places in the mold; the rim is then cast onto the spokes. The hub of the pulley is cast the next day, so that all danger of shrinkage strains is avoided. The only difficult feature in the design of this pulley is that of determining the required number of spokes and their diameter. To make the problem capable of mathematical solution, it is assumed that the rope in passing

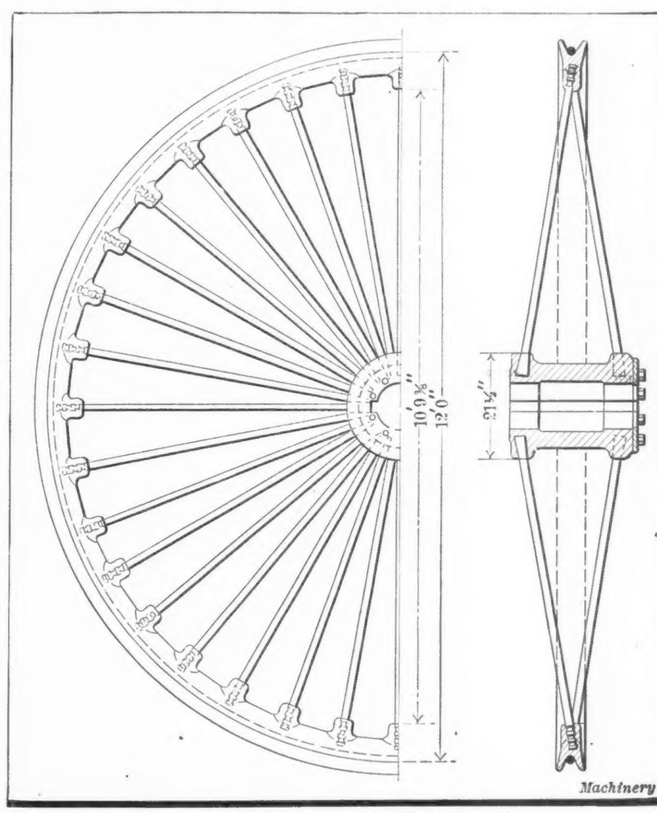

Fig. 1. A Common Type of Pit Head Rope Pulley

over the sheave is stretched from one spoke to the next in a straight line, as illustrated at the left-hand side of Fig. 2. From this diagram we can lay out the triangle of forces as shown at the right-hand side of the same illustration. The lines A, B, C, etc., representing the pull on the rope are drawn parallel to the lines A, B, C in the left-hand diagram. The lines X, Y, Z, etc., in the triangle of forces are then drawn parallel to the center lines of their respective spokes as shown at the left of the illustration; the lines X, Y, Z represent the thrusts on the spokes. In drawing the triangle of forces, some convenient scale is adopted and the line of action of the forces is obtained from the left-hand diagram; the triangle of forces can then be scaled off to determine the amount of the thrust in the spokes represented by X, Y, Z, etc. For example, the line A is drawn to represent 21,000 pounds on a scale of 14,000 pounds to the inch, and by measuring the line Y, we find that it represents a thrust of 3660 pounds which is the compression load carried by each of the upper spokes. These spokes came under the mechanical treatment of columns fixed at both ends.

In the preceding treatment, no account has been taken of

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the amount of the load which is carried by the spokes in the lower half of the pulley. As the load they will carry in tension depends entirely upon the gripping power of the cast-iron rim on the spokes, it is not possible to calculate what part of the load they can be depended upon to take. The stiffness of the rim against deformation from its circular form also adds something to the total strength of the pulley, and to cover these two items, the writer's practice is to add one-third to the strength arrived at in calculating the safe load on the spokes in the upper half. The same result may be obtained by deducting one-fourth of the actual pull of the rope. To take a concrete example, we will assume that a pulley is required to carry a load which puts a tension of 28,000 pounds in the rope, the diameter of the pulley being 12 feet from center to center of the rope. As previously stated, we will consider that one-fourth of this load is carried by the lower spokes which are in tension, leaving 21,000 pounds to be carried by the upper spokes in compression. It will be necessary to assume the required number of spokes and for a 12-foot pulley, the usual number is thirty-six. The load on each spoke is 3660 pounds, as determined in Fig. 2. To find the required diameter of the spokes, the design must be carried out far enough to determine the unsupported length of the spoke which is shown in Fig. 1 to be 4 feet, 5 15/16 inches, or say 54 inches. Referring to Kent, we find that Gordon's formula for wrought-iron columns is as follows:

$$P = \frac{40{,}000}{1 + \frac{1}{40{,}000}\left(\frac{L}{R}\right)^2}$$

in which:

P = ultimate strength per square inch,

L = length of the spoke in inches,

R = least radius of gyration of the spoke section in inches.

With this formula, it is necessary to find the correct diameter by a "cut and try" method; we will try a diameter of 1⅜ inch. The radius of gyration of a circle 1⅜ inch in diameter is 0.34375 inch. Substituting this value for R, and 54 inches for L in the column formula, we have:

$$P = \frac{40{,}000}{1 + \frac{1}{40{,}000}\left(\frac{54}{0.34375}\right)^2} = 24{,}950 \text{ pounds per sq. in.}$$

The area of a circle 1⅜ inch in diameter is 1.4849 square inch, and multiplying the result obtained by substitution in the column formula by this figure, gives the value of the collapsing load on the 1⅜-inch spokes as

$$24{,}950 \times 1.4849 = 37{,}000 \text{ pounds.}$$

This value must be divided by a factor of safety to find the safe load that the spokes can carry. The writer's experience has shown that a factor of safety of 10 is correct for this service, as the stresses form a "live load" varying from a maximum compressive load to a maximum tensile load for each revolution of the pulley. It must also be remembered that a sudden jerk in starting, due to slack rope, may cause the strain to become double that due to the normal load. Using 10 as the factor of safety, we have a safe load of 3700 pounds, which is on the safe side, the value determined by the graphical method being 3660 pounds.

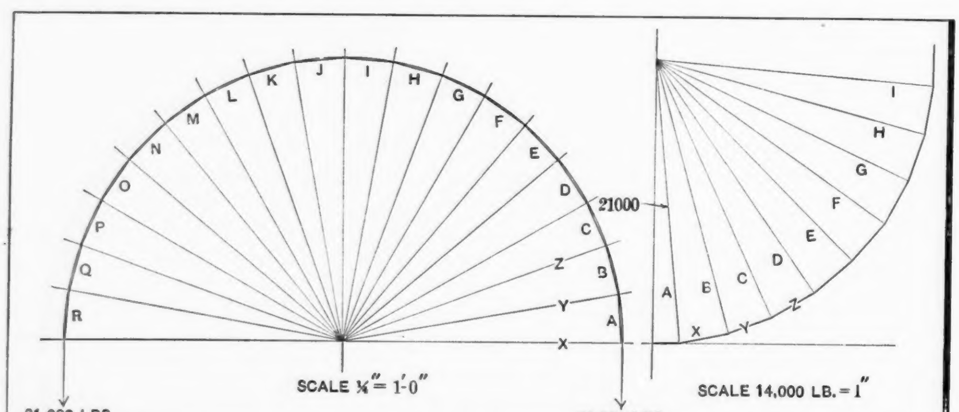


Fig. 2. Graphical Method of determining Thrust in Pulley Spokes

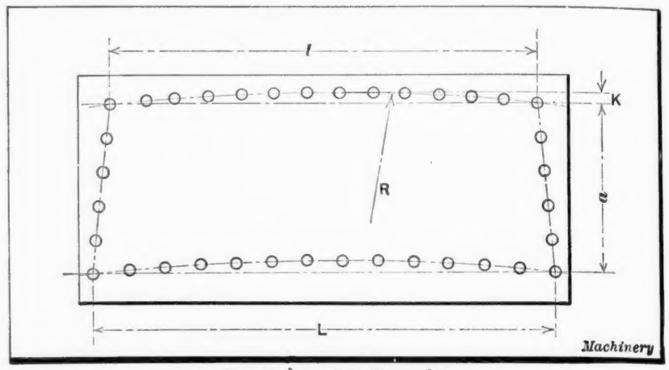
Reduced to the least number of words, the method may be said to consist of the following steps: Consider that three-fourths of the load on the rope is carried by the upper spokes in compression, and one-fourth by the lower spokes in tension. Then by the triangle of forces, find the resultant strain on the spokes and make them large enough to carry that load as a column fixed at both ends.

* * *

CAMBER IN PLATES

BY R. H. CREVOISIE*

When the specifications for certain work do not allow the drifting of rivet holes, or in a stack or stand-pipe, when the plates are thick and the lower lap of the top ring is on the outside of the upper lap of the bottom ring, it is necessary, in order to have the holes match, to throw a camber in the plates. This can be determined by the following formula:



Notation used in Formulas

$$K = \frac{L\,(L - l)}{8a} \quad (1)$$

in which the reference letters denote the dimensions given in the accompanying engraving.

As an example, assume that a stand-pipe is 20 feet in diameter on the outside of the inner lap and 20 feet 1½ inch in diameter on the outside of the outside lap. This would make the thickness of the plates in the rings ¾ inch. Assume that four plates are used for each ring, and that the center to center distance a of the girth seams is 5 feet, or 60 inches. We then have:

Circumference of outside of inner lap = 754 inches;

Circumference of outside of outside lap = 758.7 inches.

From this we get:

$l = 754 \div 4 = 188.5$ inches;

$L = 758.7 \div 4 = 189.67$ inches.

Then, by applying Formula (1), we have:

$$K = \frac{189.67\,(189.67 - 188.50)}{8 \times 60} = 0.46 \text{ inch.}$$

* * *

A patent has recently been granted in England for the use of solid cylindrical rollers cut from round rods of vulcanite or similar material to be used in roller bearings. The use of rollers of this material will not, it is claimed, injure the journal of the shaft which is rotating in the bearing nor the bearing itself in which the rollers work, but will reduce to a minimum the wear of both journal and bearing. The rollers, when worn, may be replaced by new rollers of the original dimensions which will render the roller bearing equal in all respects to a new one.

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METHODS OF LUBRICATING MACHINE TOOLS—2

A REVIEW OF OILING DEVICES AND SYSTEMS OF DISTRIBUTION

BY JOSEPH HORNER*

Continuing our study of various distribution systems, there are numerous instances in which the difficulty of reaching concealed bearings results in the adoption of special pipings,

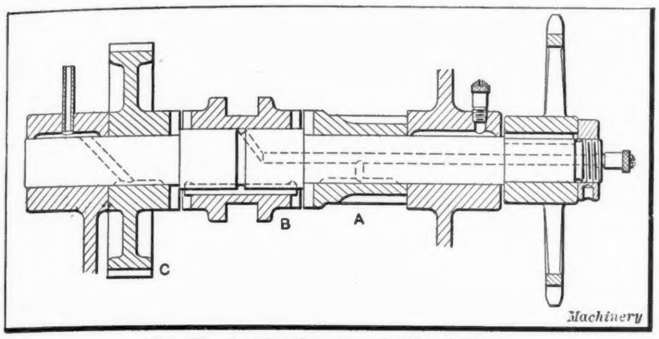

Fig. 27. Lubrication from Inside of Shaft

or passages, which betray ingenuity in their disposition. The advent of all-geared drives for speeds and feeds greatly complicated the matter. One of the commonest practices is to drill a longitudinal hole in the shaft, and connect radial holes with this to lead out to the various bearings or wheels. Usually the lubricant is supplied through the shaft end, but it may have to be fed from a radial or inclined hole in some

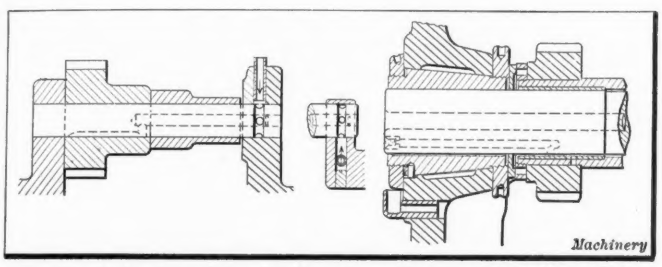

Fig. 28. Mode of supplying Oil through Hollow Pin Fig. 29. Lubrication of Loose Wheel through Separate Hole

circumstances. Fig. 27 is selected to illustrate both ways, the pinion and clutch *A* and *B* receiving oil through the shaft from the end oiler, and the wheel *C* its supply from the inclined passage fed from the piped bearing adjacent. The reason for turning the semicircular groove in the shaft at the place where *B* is situated is that, as the latter does not revolve, there would be no opportunity for the oil to spread

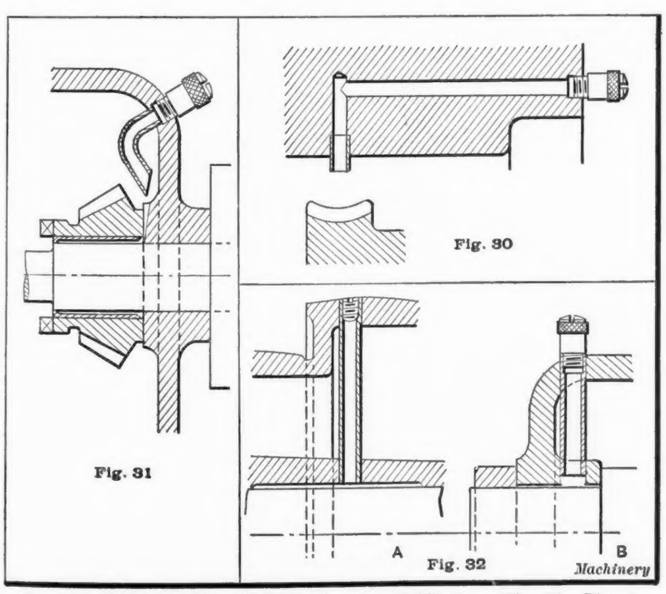

Fig. 30. Holes and Directing Pipe to prevent Waste. Fig. 31. Directing Pipe inside Gear-box. Fig. 32. Pipes employed to span Gaps

itself circumferentially. Fig. 28 shows a method of supply to a fixed pin on which is a pinion and a distance-piece. A groove is turned in the pin where it rests in the bearing bracket, and a transverse hole leads the oil from this to the central passage. In places where it is not feasible to lead a pipe in from above, as shown, on account of the proximity of gears or other details, a lateral pipe can be inserted (see the detail view, Fig. 28) to fill the vertical hole up which the oil rises to the pin. This pipe is either disposed horizontally, or slopes down, or if a head is available from a well or tank or pump supply, it can be brought up from below.

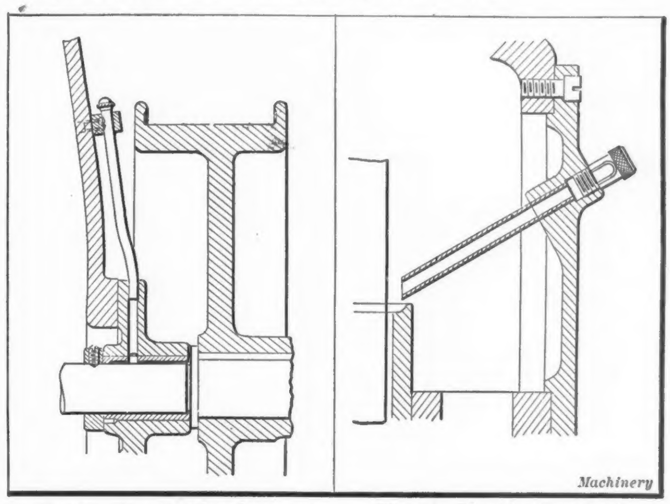

Fig. 33. Pipe fitted to Inaccessible Bearing Fig. 34. Directing Pipe Lead through Cover

In a few instances it is impracticable to conduct oil through the center of a spindle, on account of this being wanted for the passage of a draw-rod or a chuck tube. In such a case a special oil-hole is drilled, Fig. 29, in the metal between the central hole and the outside. This is from a Brown & Sharpe milling machine spindle.

The combination of holes and pipes is frequently necessary

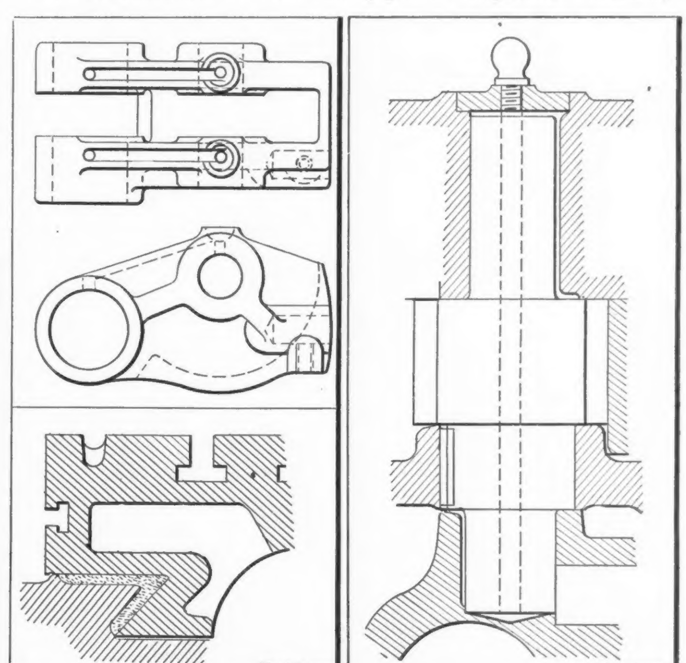

Fig. 35. Tumbler Bracket with Long Troughs. Fig. 36. Felt Pad let into Pocket of Milling Machine Slide. Fig. 37. Lubrication of Top and Bottom Journal

to conveniently reach awkward situations; sometimes the oil passes for a certain distance through a hole and then finishes its journey by way of a pipe for precision of location. The ease with which pipes can be bent and carried around angles greatly assists in their disposition, and often saves awkward or expensive drilling. But sometimes a pipe is fitted solely to prevent creeping, such as is seen in Fig. 30. Here the oil is fed through the oiler at the side of the table, and passes to the vertical hole, from which a bit of pipe depends and

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causes the oil to drop on the worm-wheel, none of it being wasted by creeping along the under side of the slide. Fig. 31 shows the location of a short bent pipe to reach just inside a gear-box, and lubricate a clutch bevel gear bushing, which is grooved to distribute the oil that drips down the recess cut in the bearing face.

Piping is largely utilized to span gaps where the lubricant could not be supplied with certainty, and without waste, to the interior oil-hole. With but a short distance for the oil to

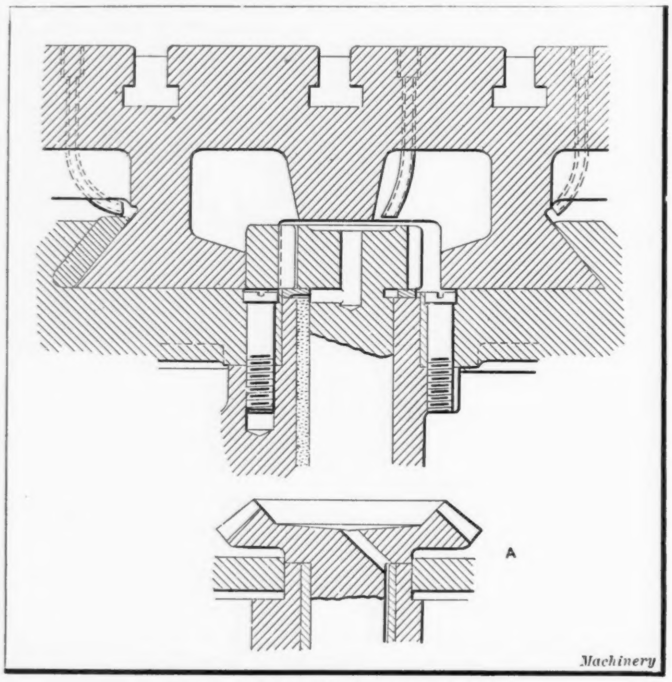

Fig. 38. Lubrication from Top of Table

travel, and an ample bell-mouthing of the hole, it would be feasible to dispense with the conducting tube, but even here some waste is likely to occur, and carelessness of the attendant or movement of the parts before the oil has reached its destination will increase the loss. Two kinds of tube fittings are seen in Fig. 32, *A* being that applied to a loose-running cone-pulley, to span the gap between boss and rim, and the other, *B*, in a gear-box where it is necessary to put the oiler on top, and a pipe then carries across the space between the walls. The close proximity of a pulley or other detail often renders

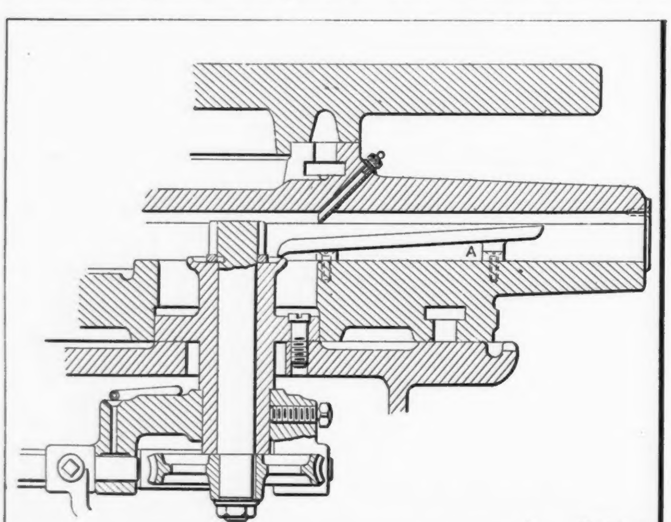

Fig. 39. Arrangement of Trough to catch Oil from Pipe

it impracticable to reach a bearing with an ordinary oil-can spout, and as it is not worth while using a special can for such purposes, the plan of arranging a pipe is followed, as in Fig. 33, the top being closed with a plug, or an oiler. When a number of such pipes have to be used, it is usually best, if circumstances allow, to bring the terminations all together at one spot, not necessarily into a tank, but alongside into a holding block, and thus have them handy for attention.

Fig. 34 illustrates a mode of applying a pipe to lead a supply to the recessed top of a bearing for a vertical shaft, the tube and its oiler being screwed into the door, which need not be removed except for purposes of repair.

The practice of covering in sets of gears with casings which are necessary for protective purposes, or may form an integral part of the design of bearings and lever anchorages, frequently renders some amount of piping necessary, to lead from the

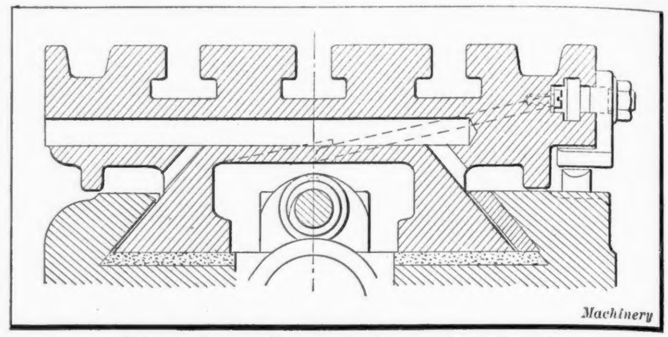

Fig. 40. Milling Machine Table oiled from the Side

external oilers to the various bearings. The alternative is to drill the shafts and convey the oil by way of these, but it is sometimes inconvenient to do so. The oil-pipe either leads from the cover to the bearing, or hangs some little way off and lets the oil drop into the cupped hole, or a raised rim, as the case may be. Sometimes a bushing is screwed into the bearing and has a flanged head, with an ample bell-mouth, to catch the oil. The cover can be removed and replaced without dis-

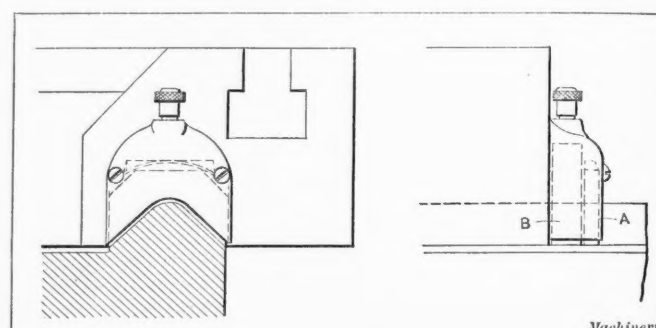

Fig. 41. Shear Wiper, with Leather Strip and Felt Pad

turbing any connections, which is not the case when the pipes actually enter the bearings and fit into them.

In a great many feed-gears and other details it is impossible to apply oil directly to certain of the bearings, because of their inaccessibility, and in such cases it is often the practice to provide a single trough on the top of a fixed or a tumbler casting, and drill holes and fit and bend pipes suitably to reach the other bearings. In order to prevent waste of oil, the trough is sometimes divided by partitions, thus providing each

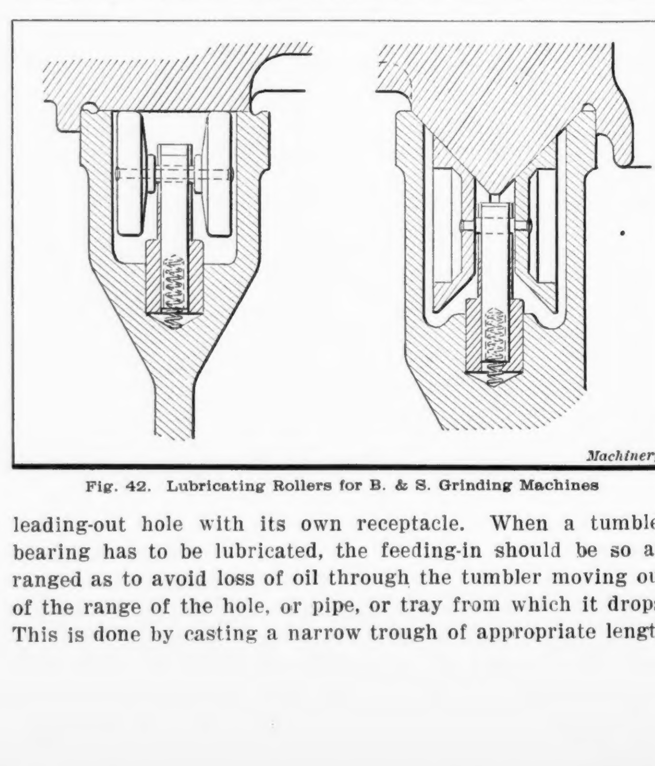

Fig. 42. Lubricating Rollers for B. & S. Grinding Machines

leading-out hole with its own receptacle. When a tumbler bearing has to be lubricated, the feeding-in should be so arranged as to avoid loss of oil through the tumbler moving out of the range of the hole, or pipe, or tray from which it drops. This is done by casting a narrow trough of appropriate length

on the tumbler. Fig. 35 illustrates a common design, with a cup on the higher bearing communicating by a groove with the hole in the end hole. The groove comes under the end of the pipe through which the oil is fed, and never moves out of its reach.

In some of the more complicated designs of machines, special provisions are necessary to lubricate parts that are subject to frequent change of position—slides specifically. This is seen

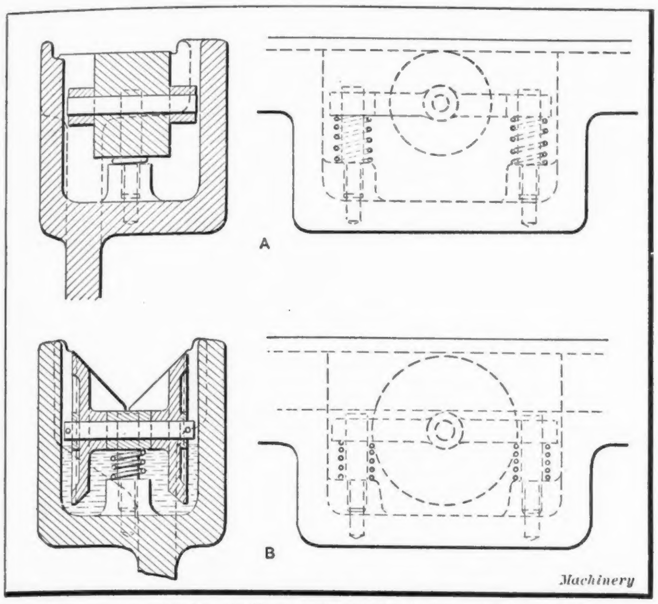

Fig. 43. Lubricating Rollers and Well for Birch Grinding Machine

for example in the portion of a Brown & Sharpe grinding machine, Fig. 39, where a sloping chute, *A*, receives the oil from the tube and oiler in the slide above, and conducts it over the lip of the bearing to the vertical shaft. Any alteration in position of the upper slide consequently makes no difference, and there is no waste, but all the oil from the inlet is caught. In slides not suitably provided in this manner, it may be essential to bring them to a definite position, put in the oil, and wait for a certain time to permit it all to escape. In this illustration the bearing for the shaft by the worm-wheel is lubricated from a bent pipe taken to the outside of the frame.

Another illustration of an awkward situation is seen in Fig. 45 (also by Brown & Sharpe) the vertical shaft obtaining its

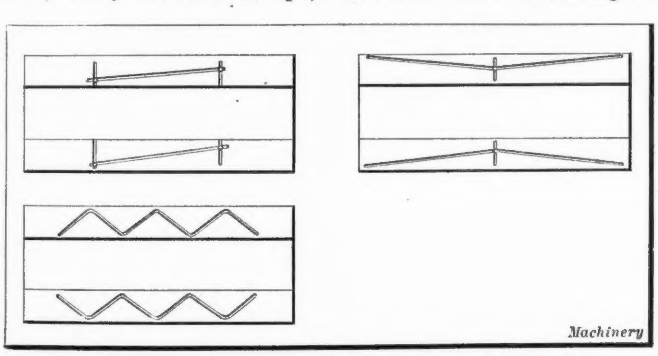

Fig. 44. Various Arrangements of Oil Grooves on Flat Surfaces

supply from the pipe above, discharging into the groove and thence to the bush groove, while the worm is lubricated from a combination of holes and pipes, with a trough to maintain the worm in oil constantly. Fig. 45 *A* shows a little point in connection with the conduction of oil through slides, from an upper one to another; to prevent the oil from spreading in a film under the slides, the lower face is counterbored to catch the drip from the edges of the hole and lead it properly into the continuation hole.

The lubrication of tables presents some rather interesting variations in methods of supply and distribution. Much depends on the size and weight to be dealt with, and on the speed of movement. A slow moving table or slide, or one subject only to occasional alterations in position does not require so much lubricant as a rapidly moving one in which the oil is swept off more quickly, or squeezed out by pressure.

A small table, such as on a cutter grinder, for instance, can be oiled satisfactorily enough by the can, pouring onto the surfaces while the table is run back. If the length prevents this being done, lateral oil-holes are drilled, and vertical ones to communicate with the under side of the table face. Or, if vee slides are used, diagonal holes are drilled. Grooves or pads distribute the film evenly over the surfaces, and pads have the merit of retaining a portion of oil and keeping the surfaces moist for considerable periods. Several such pads can be inserted in pockets in the slide, see the sectional view, Fig. 36, and the oil is then supplied by a passage to each pad.

The location of the oil-holes or plugs or oilers is a matter for consideration in certain types of tables. In some grinding machines there is no objection, for instance, to drilling the holes vertically from the table top, and letting in plugs or spring caps. But in other machines these areas might be

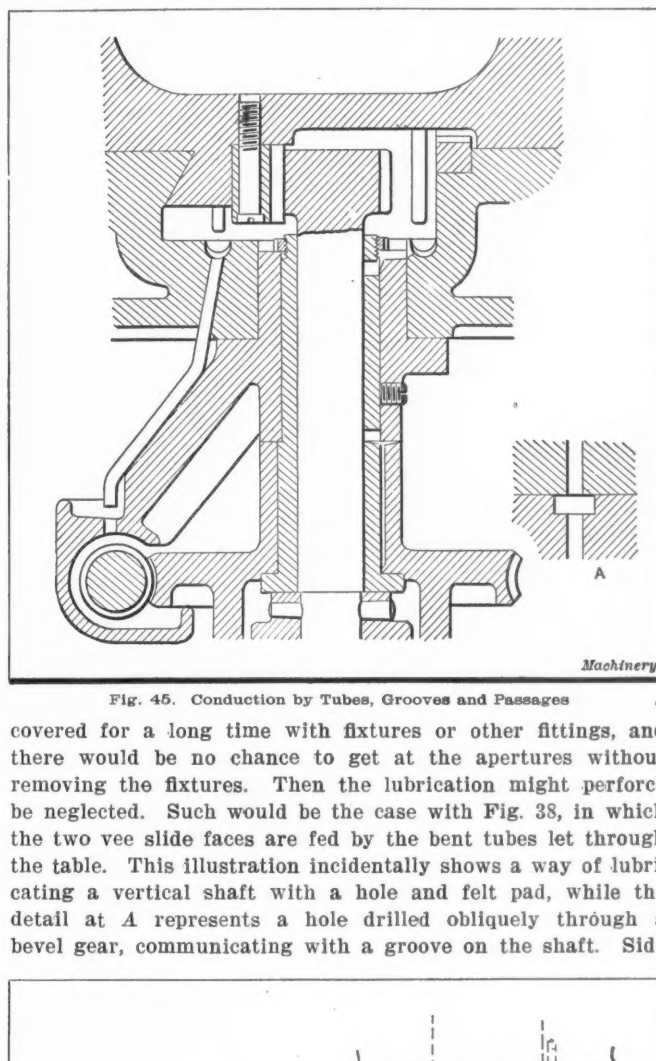

Fig. 45. Conduction by Tubes, Grooves and Passages

covered for a long time with fixtures or other fittings, and there would be no chance to get at the apertures without removing the fixtures. Then the lubrication might perforce be neglected. Such would be the case with Fig. 38, in which the two vee slide faces are fed by the bent tubes let through the table. This illustration incidentally shows a way of lubricating a vertical shaft with a hole and felt pad, while the detail at *A* represents a hole drilled obliquely through a bevel gear, communicating with a groove on the shaft. Side

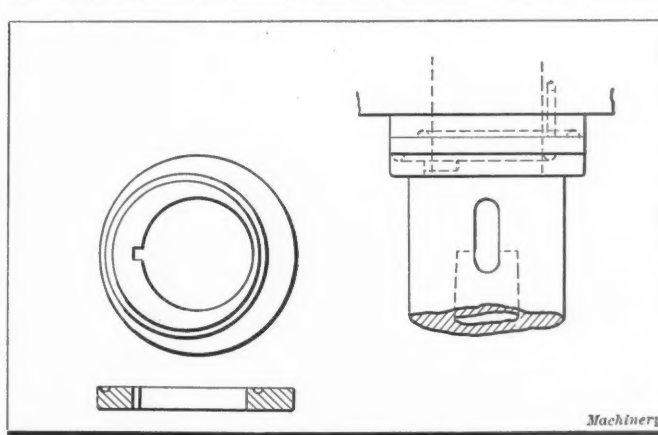

Fig. 46. Eccentric Groove for distributing Oil

oiling is seen in Fig. 40, with an extra pipe to lead to the bearing at the center.

A felt pad happens to serve conveniently as a means of keeping surfaces clear of cuttings, although it is often applied in conjunction with something more solid, such as a piece of leather *A*, Fig. 41, in front of the oiling pad *B*. This is from the Lodge & Shipley lathes.

The most effective method of lubricating a heavy table or slide, such as that of a planer, or heavy shaper, or grinder, or boring mill, is to employ rollers sunk into oil-pockets, thus forming an automatic device independent of the operator's care, and providing a supply of lubricant at each return of the table, or as fast as it is squeezed out. The primitive device is simply to float a wooden roller in the oil-pocket, but it should have some means of attachment to prevent its rising unnecessarily high after the table has passed. Of course, in rotating tables, as in boring mills, a roller would remain in the same position. But even then it is as well to afford a definite pressure by springs, which will result in proper rotation and an increase in the amount of oil smeared on. Fig. 42 illustrates the type of roller fitting used in the Brown & Sharpe grinding machines, for the flat and the vee ways, respectively. The wheels are mounted on a cross-pin held in a central plunger, which slides up and down in a casing, being maintained in the normal position at the top by the coiled spring. Messrs. G. Birch & Co., Ltd., of Manchester, England, employ frames like those seen in Figs. 43, *A* and *B* to lubricate the tables of their grinding machines. Screwed into bosses at the ends of the oil-pocket are studs, encircled by springs, and receiving the ends of the frame which supports the roller. This construction permits the plain roller (Fig. 43 *A*) to be made without a break across its face. It will be noted that the vee wheels do not reach right across the slope of the vee, but this is a matter of no consequence, since gravity makes up for the deficiency in this respect.

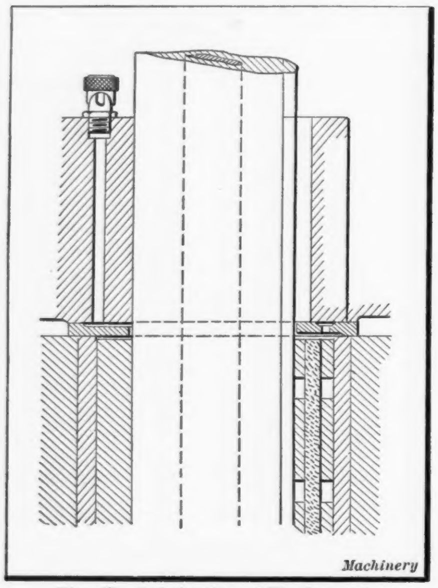

Fig. 47. Lubrication of Washer and Vertical Bearing

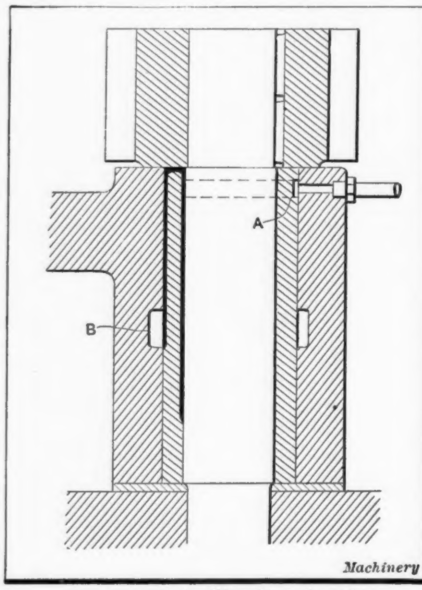

Fig. 48. Wick-oiling from Annular Reservoir

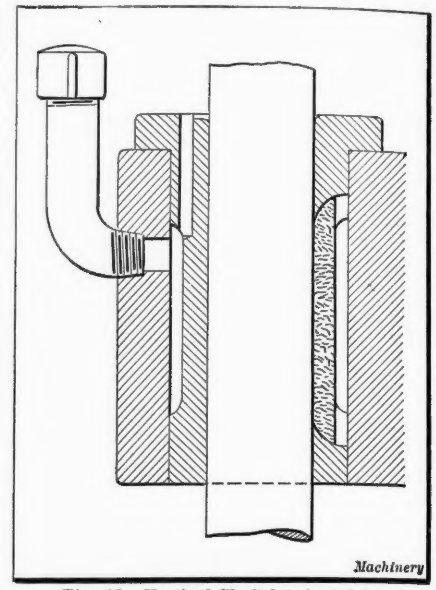

Fig. 49. Vertical Shaft lubricated from Reservoir and Felt Pad

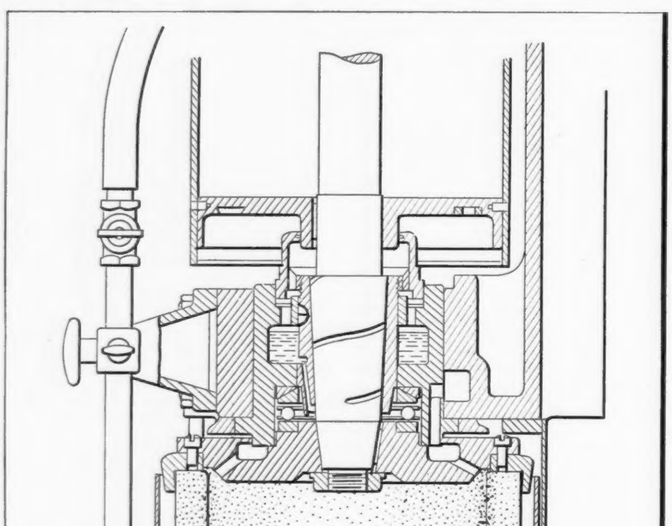

Fig. 50. Blanchard Grinder Spindle with Spiral Oil-raising Groove

Slides which are not lubricated across their bearing width by rollers or pads require grooves to properly distribute the oil. The aim in the disposition of these is to spread it nearly across the width, and numerous fashions are followed, though results are much the same. The precise arrangement may often depend on the position and number of the oiling holes. In a vertical knee or slide with a single oiler at the center on the top edge, the grooves radiate from this to right and left. Fig. 44 gives three alternative dispositions for milling-machine tables moving horizontally. The zig-zag style is a favorite one, and is used also largely on circular tables like those in boring mills, carrying a good supply of lubricant in its length.

Relating to the question of spreading oil on the class of surfaces just dealt with is that of lubricating collars and washers disposed horizontally. Grooves are used variously, and in washers that have to make running contact on both sides, the oil is usually carried through holes, Fig. 47. This, from a Brown & Sharpe vertical spindle milling machine, includes provision for feeding the vertical drilled bush of the spindle. Fig. 46 shows a method of grooving, for horizontally and vertically set washers, which is easily produced; the washer or collar is set eccentrically in the lathe, and the groove turned as seen. This distributes the oil all over the faces, excepting at the extreme edge, where it is necessary to keep the groove from opening out.

The action of the centrifugal force is utilized in more than one instance to spread oil over faces, a good example being that of boring-mill spindles. The conical face is submerged in oil,

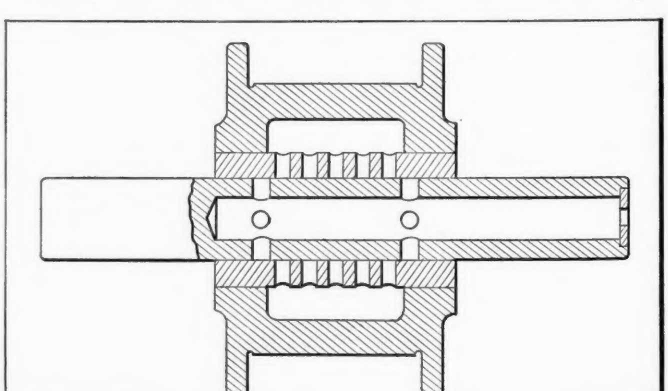

Fig. 51. Loose Pulley with Perforated Bushing and Grease Chamber

and when the spindle starts running the oil is thrown outward against the guard lips surrounding the face, and then runs back down through grooves cut in the bearing face, constantly flushing the same. The same supply is also generally utilized to oil the vertical portion of the spindle through an overflow, or by pads, or spiral grooves.

Vertical spindles present some difficulties in regard to efficient lubrication which do not exist in horizontal ones; this

is due to the inevitable tendency of the oil to run down and out of the bearings quickly. Ring-oiling is out of the question, and if a considerable quantity of oil is required, pads must be used, or the oil must be kept in constant motion and supply by spiral raising grooves. An ordinary mode of supply is adopted in the vertical shaft illustrated by Fig. 37; the oil is poured in, on the removal of the stopper, both through the central hole, and around the top of the shaft, thence flowing by the bearing grooves around the bottom and top journals.

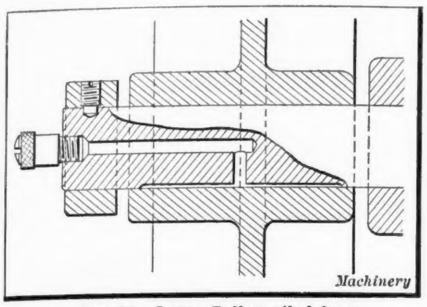

Fig. 52. Loose Pulley oiled from Hollow Shaft

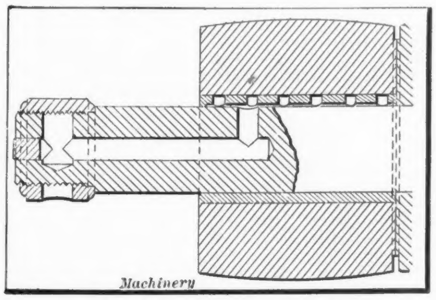

Fig. 53. Loose Pulley greased from Hollow Shaft

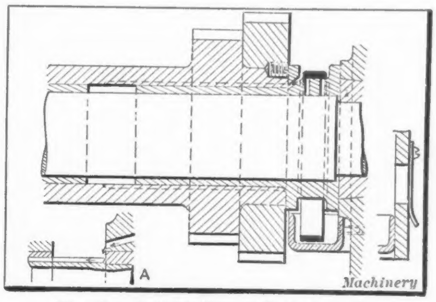

Fig. 54. Lubrication of Loose-running Wheels

Wicks are employed very extensively to conduct and distribute oil to vertical bearings, such as shown in Fig. 48; the annular groove *A* near the top of the bush is fed from a pipe, and the oil runs down into the reservoir, *B*, from which the end of a wick (indicated in black) is carried up and down into a groove cut in the bush. Bringing the wick to the top also provides the lubrication of the pinion face. If a reservoir of oil is close at hand, the wick can be brought direct from this, and the piping is not then required. The application of felt

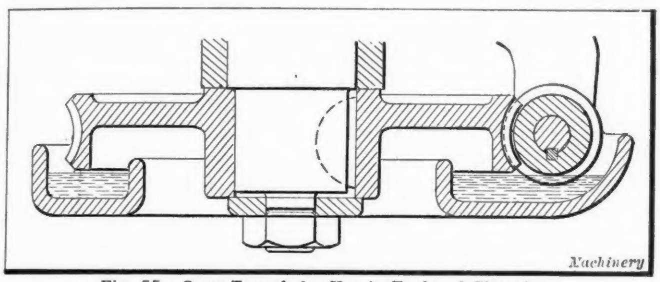

Fig. 55. Open Trough for Use in Enclosed Situation

to retain oil is shown by Fig. 49 (from the American Tool Works Co.'s radial drills). The chamber cut around the bronze bushing stores a good supply of lubricant, which is fed slowly to the shaft by the felt pad. Waste leakage occurs at a slow rate.

A good example of the use of raising grooves is shown by the sectional view of the Blanchard Machine Co.'s grinder bearing, Fig. 50. Several points may be noted in this. In the first place the bearing casting is cored out to hold about a quart of oil, which flowing through the passage drilled in the phosphor-bronze bushing, communicating with an annular recess, is caught by the tail end of the spindle groove and thence is screwed upwards to the top of the tapered journal thus distributing a film of oil all over the surface. It then overflows into the oil guard, and falls down through the holes in the same and so again into the reservoir. An oil-gage (not shown) indicates the height, and serves for replenishing. A fact which helps to the efficient operation of this system is that the casting being also cored out with passages for the transmission of the water going to the wheel, this water passing in close proximity to the oil chamber, keeps the latter cool, and consequently the heat is carried away. The lubrication of the ball-thrust bearing is from a separate compression grease-cup.

We have already dealt with some examples of the lubrication of loose-running wheels, but there are other aspects to which attention may be drawn. The loose pulley forms an interesting subject for consideration, for it is likely to give a good deal of trouble if neglected. Roughly, there are three main systems of lubrication (1) The simple use of a lubricator of ordinary, or Stauffer type, screwed into the hub, and giving a moderate supply as required; (2) A chambered hub with capacity to hold oil or grease sufficient for a long run; (3) A hollow shaft through which oil is fed, and thence distributed to the bore by a perforated bushing, or grooves, or a wick, or pad. In the chambered hub design the oil or grease simply exudes through on to the shaft or it is properly distributed by a wick or pad laid in the bore. Fig. 51 shows a grease chamber within the pulley, and a perforated bush, the lubricant being fed in through a hole at the end of the fixed pin. The simplest mode of oiling through the hollow shaft is shown by Fig. 52, with grooves in the shaft for distributing purposes; often two more holes are drilled in to meet the central one, if the bore is exceptionally long. In Fig. 53 a perforated bush is shown, and the grease is admitted to the shaft on turning the cylindrical closing cap, which has a large opening.

Fig. 54 represents an ingenious arrangement designed to oil a loosely-running set of gears, of which one end only is shown. An ample quantity is provided by putting an oiling ring on the shouldered portion of the sleeve, to dip into an oil trough screwed to the inside of the framing, and the oil thus raised goes through the holes below the ring, and also down a sloping hole connecting with longitudinal oil-grooves. Constant lubrication is therefore assured without need for stopping the machine. The trough is replenished through the opening in the frame—a detail of this is seen on the right—with a swivel closing door. Another way of leading oil to a grooved shaft is seen in the detail, *A*, there being a hole led from outside, down which the oil flows and into the shaft groove. But this does not act constantly, like the ring device.

Submerged lubrication, that is by running parts in a bath of oil or grease which they continually stir up and spread over themselves, exists in many forms. In the oil-bath as correctly arranged there is never any lack of lubricant and the chief care is to see that sediment does not become thrown up, or that any parts are shielded from the spread of oil. The familiar worm-gear and spiral gear drive running in an oil

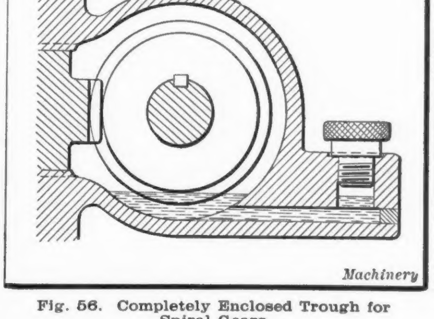

Fig. 56. Completely Enclosed Trough for Spiral Gears

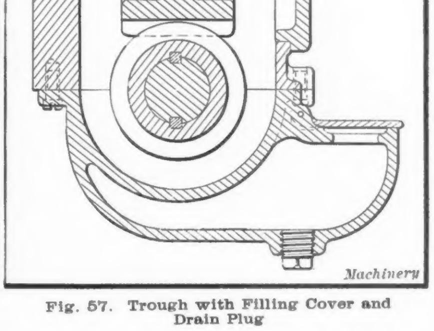

Fig. 57. Trough with Filling Cover and Drain Plug

trough was followed by the geared-drives in which other classes of gears are caused to dip in oil and splash it over the teeth. Fast-running gears necessitate complete covering to prevent the oil from flying out of the box. But in worm-gears it is not always necessary to afford absolute protection, as for instance where the trough is situated within a framing, and dust or grit cannot enter. A half-trough, as in Fig. 55, is all that is required then. When, however, the box is situated in

the open, complete enclosure is usually desirable, Fig. 56. Fig. 57 shows an oil chamber cast on to the under cover of a worm-gear box (Brown & Sharpe), with provision for filling, cleaning, and draining. The main body of oil being outside the worm casing proper, all the dirt and sediment collects in a place where it is not churned up by the rotation of the worm.

The action of gears running in an oil-bath can be sometimes utilized to lubricate the adjacent bearings as well, in

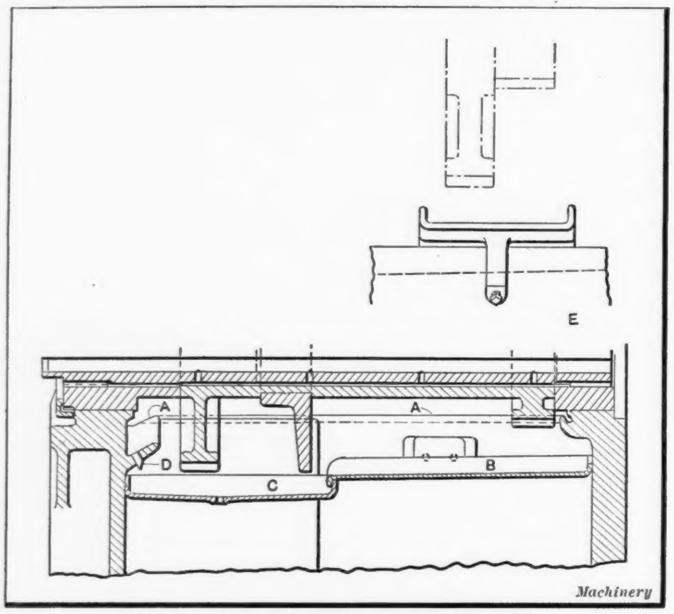

Fig. 58. Lips and Troughs to catch Waste Oil

place of fitting separate oilers to these. But care must be observed that these bearings get a sufficient amount, which is not always the case in badly designed boxes. The oil which is thrown up by centrifugal force to the roof of the box may have to be deflected by various arrangements so as to direct it into the oil recesses above the bearings. Sometimes a passage is forced in the casting to lead down to these points, or ribs are cast or screwed on to catch the flying oil and let it run down and drip at the place required, without actually

posely retained within its working area for some time, while in others no such attempt is made, and it is allowed to flow away immediately. This difference is reflected in the draining arrangements, which are of a very complete character in the continuous flow system, and as all the oil flows back to the tank there is no external waste. On the other hand, with simple oiling systems some amount of waste may occur, which is detrimental also to the appearance of the machine. And what is worse, the oil may get onto belts or other portions where it is very undesirable; frequently special devices are fitted to prevent oil creeping or flying in such a fashion.

The principal means of prevention of waste are the fitting of felt disks or pads, the use of closed oil-grooves, caps on the ends of bearings, and the inclusion of ledges or lips to arrest flying or flowing oil. The saving or catching is done by channels, by lips, by troughs, by pipes, or by the simple flow down the inside of a framing to the tank at the base. A return of waste to definite positions is required in the case of wells which carry rollers or pads, or wicks, or rings, etc., and this is done by first confining the oil by channels and leading these to the spot required.

In a machine which has a flooded system of lubrication of gears and bearings the design must be accommodated so as to enclose all the drainage outlets, and conduct the oil to a common tray, or to the bottom of the box framing. But there are many systems in which a partial arrangement is adopted, in the form of lips, grooves, cups, sloping trays, etc., to collect the waste from the various locations and pass it to a final collecting area. The two illustrations from Brown & Sharpe milling machine construction, Figs. 58 and 59, indicate various points. The first shows the fitting of cast-iron trays below a set of gears (a portion cnly of the lowermost shaft being seen). The oil lost from the various bearings runs down from drain lips and holes up above, and finally reaches the continuous lip *A*, extending around inside the framing, and the upper tray *B*, whence it drips into the lower one *C*. A bit of pipe inserted in the lip at *D* conducts the oil from that point into the tray. Further up, under the main spindle bearings, special provision is incorporated for preventing the oil getting on to the belt cones, by means of troughs, and a guard under the cones. The detail *E* shows how the oil thrown or dripping from the

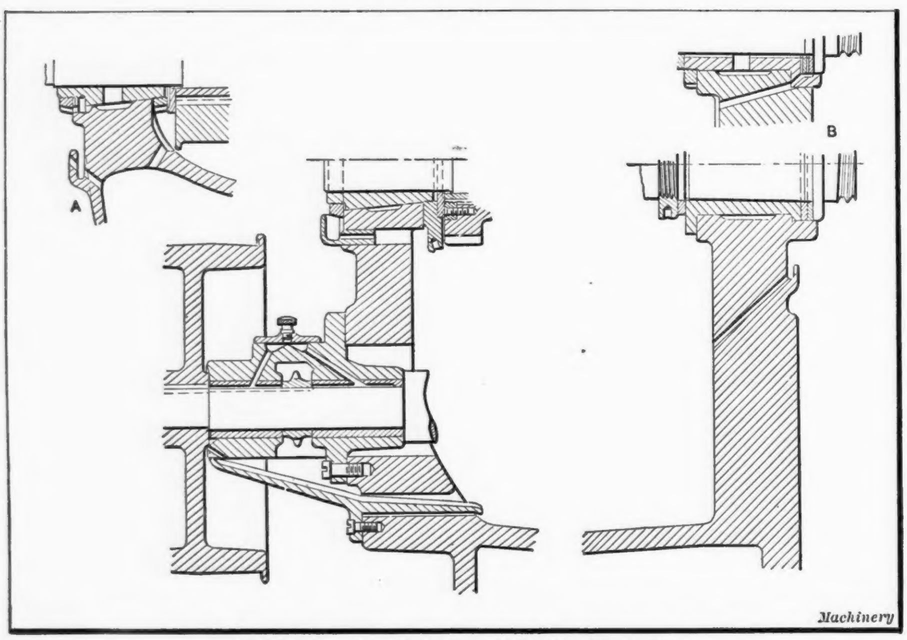

Fig. 59. Various Methods of Collecting Waste Oil

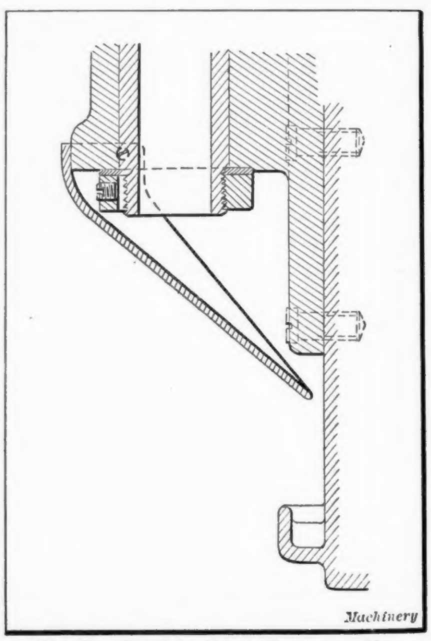

Fig. 60. Guard to divert Waste into Lip

confining it in grooves. Or a piece of piping, or bent wire may be fitted and arranged to accomplish a similar function. Occasionally a strip of metal is attached and sloped in such a fashion that the oil is thrown against it, and thence off at an angle onto the bearing, or to a channel communicating therewith.

Proper provision for the prevention of waste and the saving of oil must be incorporated in the design of machine tools. There is much diversity of practice in these respects, because conditions vary so widely. In certain instances oil is pur-

spur gears seen dotted is collected by a catcher attached to a lip, which is not wide enough to receive the oil by itself.

In Fig. 59 the waste has to be collected from the two bearings and from sundry gears and bearings, not shown but situated between and below these bearings. The sides of the framing in this view are drawn close together for convenience. The spindle bearings are served by catchers immediately below, the one cast on being of half-moon shape, the other fitted separately, and the holes drilled through the frame, permit the waste to run down into the web extending

across between the sides, which has an outlet to the tank. The long bearing adjacent to the pulley—supplied from a trough and two oil-holes—is drained by a special sloping catcher screwed on, this also leading to the web. The detail at *A* illustrates the inclusion of a groove and outlet hole close to the pulley, which prevents the oil going further down the slope, while that at *B* represents a neater method of draining into the frame, in place of the external lip. This necessitates an unsightly trickle of oil on the frame, while at *B* nothing appears externally.

Fig. 60 is an example of a guard to direct the drippings from a vertical shaft down into the draining lip of the main casting, a class of fitting that is applied to gear-boxes or to main frames where one or two bearings are located on the outside. A great many kinds of trays and troughs are hung under bearings to catch the oil that would otherwise fall on the floor, or run on to the frame. A double type of catcher is seen in Fig. 61, serving to receive the oil from the sides of the rocking gear case, and from the other end of the bearing also. Channels connecting with the one under this bearing slope down to the main reservoir.

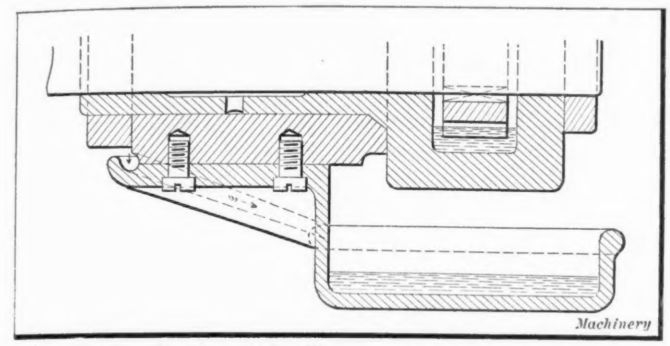

Fig. 61. Trough receiving Waste from Both Ends of Bearing

The waste which runs from the table slides of planing and other reciprocating machines is collected in a variety of ways. Oil-pots or catchers are hooked on at the ends of the bed, or are cast on, or a long box is screwed on to cover the whole width. Or the bed is cast with a rim if flat ways are adopted, running all around. Fig. 62 shows a neat mode of catching, by casting a chamber at the end of the bed, connecting each vee way with a central aperture located above a shallow tray resting on lugs. This is removed and emptied at intervals. In some designs pipes are let into the ways to conduct the oil into a similar kind of tray inside the bed.

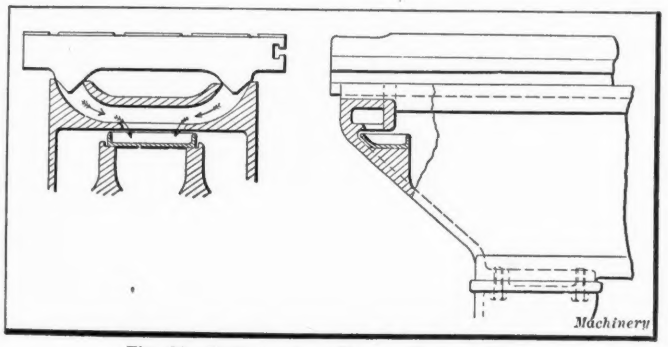

Fig. 62. Drainage from Planing Machine Ways

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An impressive collection of enlarged photographs exhibited by the U. S. Department of Agriculture at the Grand Central Palace section of the National Automobile Show, showed sections of highways before and after being improved. Roads which in the spring, fall and winter were morasses through which a team could hardly drag a light empty wagon and in which horses often fell and were smothered, have been converted into hard smooth highways on which heavy loads may be hauled to market at any time of the year. The economic value of good roads is beyond computation. The mere money saving in hauling loads is really a minor consideration compared with the moral, mental and spiritual uplift conferred on rural communities by highways that afford easy and quick means of communication.

TWIST DRILL AND STEEL WIRE GAGES

BY JAMES R. ALLAN*

There are too many gages for small diameter twist drills and steel wire. The differences in these gages are a constant source of trouble to those who have to deal with drills and steel wire; and gage numbers mean nothing except if the name of the gage employed is specified. It would be desirable if one standard gage could be adopted for the smaller sizes of twist drills, drill rods, and steel wire, all other gage systems used being canceled. An agreement between the drill manufacturers on a standard which would also be recommended by the American Society of Mechanical Engineers, and adopted by the steel makers, would soon become a universally accepted standard and would eliminate confusion and misunderstanding.

Some drill manufacturers are discouraging the use of gage sizes and are asking that the sizes of drills ordered be denoted in decimals of an inch. There are three well-known standards for twist drills and steel wire that are commonly used at the present time. These are the Stubs steel wire gage, the gage used by the Standard Tool Co., and the gage used by other leading manufacturers, such as the Morse Twist Drill & Machine Co., and Brown & Sharpe Mfg. Co. The latter the writer has termed "the manufacturers' standard."

TABLE FOR COMPARISON OF TWIST DRILL AND WIRE GAGES

Gage Number	Stubs Steel Wire Gage Diam., Inches	Drill Manufacturers' Standard Diam., Inches	Gage Number	Stubs Steel Wire Gage Diam., Inches	Drill Manufacturers' Standard Diam., Inches	Stubs & Standard Tool Co.'s Gage Nos.*	Manufacturers' Standard Gage Nos.	Diam., Inches
1	0.227	0.2280	31	0.120	0.1200	60½	61	0.0390
2	0.219	0.2210	32	0.115	0.1160	61	62	0.0380
3	0.212	0.2130	33	0.112	0.1130	62	63	0.0370
4	0.207	0.2090	34	0.110	0.1110	63	64	0.0360
5	0.204	0.2055	35	0.108	0.1100	64	65	0.0350
6	0.201	0.2040	36	0.106	0.1065	65	66	0.0330
7	0.199	0.2010	37	0.103	0.1040	66	67	0.0320
8	0.197	0.1990	38	0.101	0.1015	67	68	0.0310
9	0.194	0.1960	39	0.099	0.0995	68	..	0.0300
10	0.191	0.1935	40	0.097	0.0980	68½	69	0.0292
11	0.188	0.1910	41	0.095	0.0960	69	..	0.0290
12	0.185	0.1890	42	0.092	0.0935	69½	70	0.0280
13	0.182	0.1850	43	0.088	0.0890	70	..	0.0270
14	0.180	0.1820	44	0.085	0.0860	71	71	0.0260
15	0.178	0.1800	45	0.081	0.0820	71½	72	0.0250
16	0.175	0.1770	46	0.079	0.0810	72	73	0.0240
17	0.172	0.1730	47	0.077	0.0785	73	..	0.0230
18	0.168	0.1695	48	0.075	0.0760	73½	74	0.0225
19	0.164	0.1660	49	0.072	0.0730	74	..	0.0220
20	0.161	0.1610	50	0.069	0.0700	74½	75	0.0210
21	0.157	0.1590	51	0.066	0.0670	75	76	0.0200
22	0.155	0.1570	52	0.063	0.0635	76	77	0.0180
23	0.153	0.1540	53	0.058	0.0595	77	78	0.0160
24	0.151	0.1520	54	0.055	0.0550	78	..	0.0150
25	0.148	0.1495	55	0.050	0.0520	78½	79	0.0145
26	0.146	0.1470	56	0.045	0.0465	79	..	0.0140
27	0.143	0.1440	57	0.042	0.0430	79½	80	0.0135
28	0.139	0.1405	58	0.041	0.0420	80	..	0.0130
29	0.134	0.1360	59	0.040	0.0410	..	..	......
30	0.127	0.1285	60	0.039	0.0400	..	..	......

Machinery

* Half sizes are only included in Standard Tool Co.'s gage.

The Stubs steel wire gage is used for measuring steel wire and drill rod, but it is not used at the present time as much in this country as in the past. The gage used by the Standard Tool Co. was originally adopted for drill sizes in this country, but other manufacturers changed the numbers corresponding to certain sizes, while the Standard Tool Co. retained the original numbers, but interpolated half sizes in order to agree as to the actual diameters of drills furnished by other manufacturers. The Standard Tool Co.'s gage agrees with the "manufacturers standard" for the sizes from No. 1 to No. 60, inclusive, but does not agree with the Stubs steel wire gage. From No. 61 to No. 80, inclusive, it agrees with the Stubs gage, half sizes being omitted. It also agrees with the "manufacturers' standard," as far as the diameters used are concerned, but the numbers corresponding to given diameters are different.

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INCREASE OF BORE OF WHEELS BY CENTRIFUGAL STRESSES*

APPARATUS FOR MEASURING RECORDS OF TESTS, DESIGN OF HIGH-SPEED WHEELS, ETC.

Recent advances in high-speed steam turbines and the apparatus driven by them have opened up a great many new problems. One of these is the fact that, under certain circumstances, unless proper precautions are taken, a high-speed turbine wheel expands at the hub a sufficient amount to cause an appreciable increase in the bore, so as to make the wheel slightly loose upon the shaft.

Nature of Stresses in a Wheel or Ring

It is the purpose first to give a general account of the methods of computing stresses in circular bodies. It is assumed that the disk is thin, that is, that the thickness is negligible compared with its diameter. Then conditions are the same at all points on a line parallel to the axis. This is not strictly true, as the central part of a hub is strained differently from the ends. However, in most cases this effect is slight. At each radius in the disk there are two stresses, one in the radial direction denoted by S_r and one in the tangential direction denoted by S_t. If we consider the effect of these stresses on the metal of a thin ring at the interior of the disk, we find the circumference of the ring to be increased mainly by virtue of the tangential stress, and the thickness mainly by the radial stress. However, when a metal is extended in one direction by a stress there is a shrinkage in a direction at right angles, the ratio of the deformations being called "Poisson's ratio," which we will denote by V. For ordinary kinds of steel this has a value of 0.3; that is, the increase of the circumference of a thin ring in the interior of the disk is less than that which would be produced by the tangential stress if acting alone, by an amount which is 0.3 of the extension which would be produced by the radial stress if acting alone. Similarly, the increase in the thickness of the ring is less than that produced by the radial stress if acting alone. In any case, the ratio of stress to extension per unit length produced by it if acting alone, is given by the modulus of elasticity E, usually taken as 29,000,000 pounds per square inch.

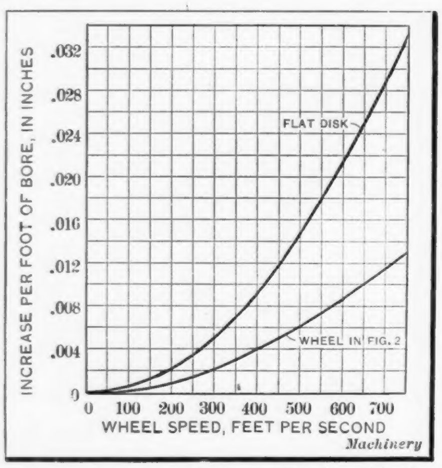


Fig. 1. Increase of Bore of a Rotating Wheel

In most cases of properly designed rotating wheels with a hole at the center, the maximum stress is the tangential stress at the bore. This is, therefore, the stress which is to be considered in order to ascertain if the wheel is safe, and is, further, the stress which must be determined in order to discuss the present problem.

Formula for Increase of Bore

As we proceed outward from the bore in a rotating wheel, the radial stress mounts up rapidly, due to the fact that the centrifugal forces of the outer portions of the disk pull outward on the inner portions. The nearer the center, the less the material in the inner circle, and therefore the less resistance to radial elongation. At the bore there is no force whatever resisting radial elongation, so that the radial stress becomes zero as this inner diameter is reached. We have then, on the inner wall of the cylinder forming the bore, material which is stressed only in the tangential direction, and the increase of circumference is exactly the same as if we had a straight bar of the same length stressed an amount equal to the tangential stress at the bore. This is expressed by the simple relation which is the fundamental equation of our problem:

$$X = \frac{S_{to} D_o}{E} \qquad (1)$$

where

X = increase in diameter in inches of the bore, due to the centrifugal stresses at a given speed;

S_{to} = tangential stresses at the bore in pounds per square inch at the same speed;

D_o = original diameter of bore in inches;

E = modulus of elasticity, 29,000,000 for steel.

It can be shown that the stresses at any point in a given wheel, or at a similarly situated point in any other wheel of similar proportions, are directly proportional to the square of the peripheral wheel speed. Hence the increase of bore varies directly with the square of the peripheral wheel speed with a given wheel. In any case of the same or geometrically similar wheels, the increase per foot of bore increases directly with the square of the wheel speed.

Numerical Magnitude of Increase of Bore

The allowable values of the tangential stress at the hub are quite high, since a centrifugal load is of the nature of a pure dead load in a beam. It is not possible to apply or remove a centrifugal load suddenly. Also, the maximum stress usually occurs only in a single set of fibers which are reinforced by adjacent fibers with decreasing stresses. There need be no "factor of ignorance," and maximum stresses can be known with as great accuracy as it is desired to give to the mathematical computations. In many cases 20,000 pounds per square inch is a conservative stress. In some cases, with special grades of steel, 30,000 pounds per square inch is possible. For a wheel with a 12-inch bore and 30,000 pounds maximum stress the increase in bore computed from (1) is 0.0124 inch, which is an appreciable amount. For other stresses and other dimensions of bore, the increase of bore is in direct proportion. When the stress is 29,000 pounds per square inch the increase in bore is 1 mil per inch of bore.

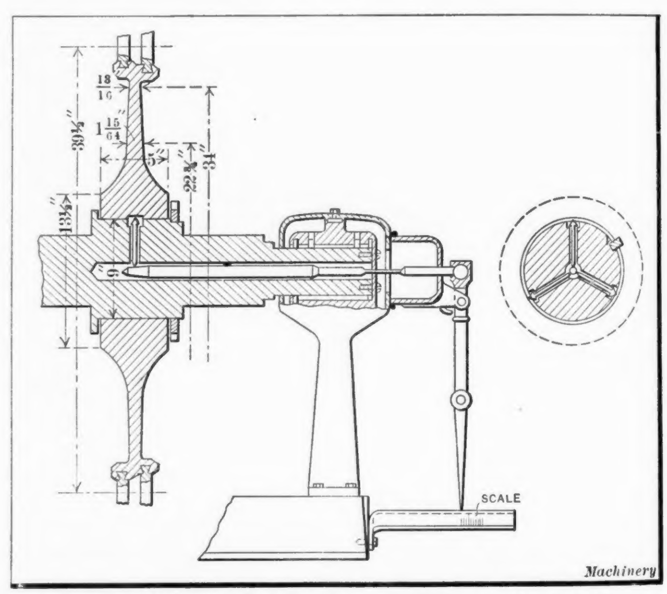


Fig. 2. Diagram of Device used for measuring the Increase of Bore during Rotation

Fig. 1 gives numerical values of increase in bore for various wheel speeds for two different shapes of disks. The upper curve is for a disk of uniform thickness. This shape is only possible with comparatively low wheel speeds and the stresses become excessive with speeds ordinarily used in turbine practice. The lower curve is for a disk of the shape shown in Fig. 2. In both cases the computations are made for a turbine bucket wheel with a load due to centrifugal force of buckets, at 3600 R. P. M. (534 feet per second), of 100,000 pounds per foot of circumference. The shapes of the curves are affected somewhat by the magnitude of this outer dead

* Abstract of a paper presented by Mr. Sanford A. Moss of West Lynn, Mass., before the Boston meeting of the American Society of Mechanical Engineers, May 17, 1912.

load. In both cases the ratio of bore to disk diameter is 0.353. The curves are not greatly affected by a difference in this ratio. They give very nearly the values of increase in bore per foot of bore for various wheel speeds for a disk of uniform thickness, which is about as poor a shape as would ever be used, and for a disk of what is probably as efficient a shape as would ever be used, with an average bucket load. The increase in bore for disks of any shape whatever will probably lie between the two curves.

Experimental Measurement of Increase of Bore of a Rotating Wheel

The magnitudes of the increase of bore in a number of actual turbine wheels, as determined by substituting com-

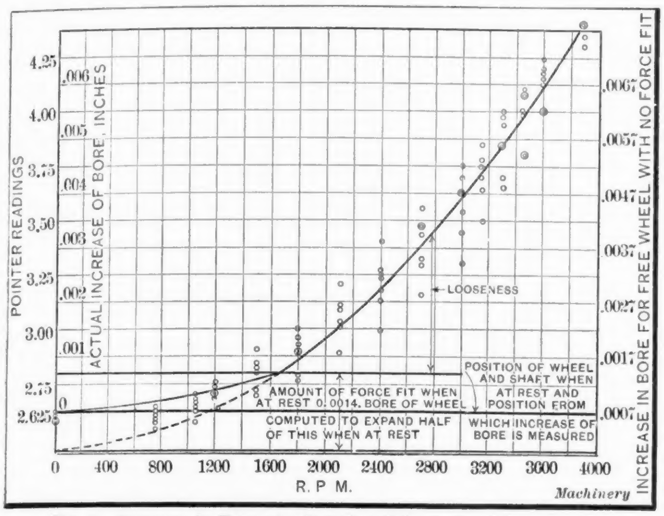


Fig. 3. Increase in Bore of a Rotating Wheel—the Points are from Tests and the Curve is drawn from Computations

puted stresses in Equation (1) came out so large that it was decided to make an actual measurement of the increase in bore when a wheel was rotating.

Fig. 2 shows the apparatus diagrammatically and Fig. 3 the results obtained. The turbine wheel was mounted on a shaft with a light force fit. A delicate micrometer arrangement was provided so that the change in bore of the wheel while it was rotating with the shaft could be observed. The wheel was gradually increased in speed and meanwhile the readings of the micrometer taken. These showed that the bore expanded at each speed an amount almost exactly equal to the value computed by the methods previously given. The mi-

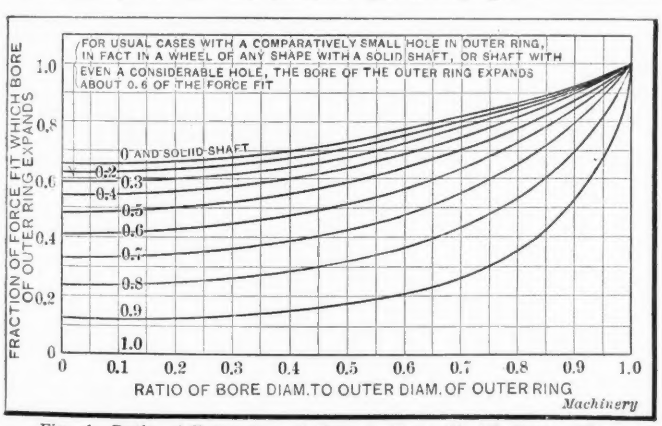


Fig. 4. Ratio of Expansion of Bore to Force-fit Allowance—Figures on Curves denote Ratio of Diameter of Hole in Inner Ring (Hollow Shaft) to Diameter of Bore of Outer Ring (Hub)

crometer arrangement proved very positive, and there was no uncertainty regarding the measurement of the increase of bore. The maximum amount measured was about 0.007 inch. The observations were accurate to about 0.0005 inch. The wheel was forced on the shaft with a force fit of 0.0014 inch, so that it was loose on the shaft by about 0.0056 inch at maximum speed.

Measuring Device

The measuring device shown in Fig. 2 consists of three pistons sliding in radial holes in the shaft. These pistons are pushed outward by means of a tapered plug moving axially in a hole in the center of the shaft. The motion of the central plug is produced by means of a lever with a ball and socket joint fulcrumed so as to give considerable multiplication at a pointer passing over a scale. A displacement of the pointer by 1 inch corresponds to an increase of bore of 0.004 inch. As the speed varied from low values to maximum value the pointer moved a distance of about 2 inches so that the change in bore was quite perceptible.

In order to find the relation between the readings of the pointer and the actual values of increase of bore, and also to demonstrate that the apparatus would give correct measurements at high speed, a calibrating sleeve was made. This was a thin sleeve bored out at each end so as to be a sliding fit on the shaft, and with two different bore diameters in the central portion, either of which could be brought over the pistons of the measuring device. Readings of the pointer were taken at each of these bores, stationary and rotating, at various speeds. The stationary readings gave the motion of the pointer for the known change of bore. The readings taken while rotating showed that the instrument gave correct readings at all speeds.

Test with Rotating Wheel

Next, the rotating wheel was pressed on the shaft. A number of readings of the diameter of shaft and bore of wheel showed that the average amount of force fit was 0.0017 inch. After this, a pair of outside calipers was set to fit the shaft at various points and a pair of inside ones set to fit the wheel bore. The difference between the two calipers was then found by means of a thickness gage. The mean of these observations gave 0.0011 inch as the amount of force fit.

READINGS OF POINTER IN TESTS WITH ROTATING WHEEL

R. P. M.	Test No. 9		Test No. 10		Test No. 11		Test No. 12		Test No. 13	
	Up	Down	Up	Down	Up	Down	Up	Down	Up	Down
0	2.61	2.62	2.62	2.63	2.62	2.63	2.63	2.62	2.61	2.62
750	2.61	2.54	2.63	2.59	2.63	2.59	2.64	2.62	....	....
1050	2.64	2.58	2.70	2.68	2.68	2 67	2.66	2.70	....	....
1200	2.69	2.63	2.74	2.72	2.72	2.74	2.72	2.75	....	....
1500	2.72	2.70	2.80	2.82	2.82	2.80	2.84	2.90	....	....
1800	2.78	2.79	2.90	2.96	2.92	2.90	2.96	3.00	....	....
2100	2.84	2.89	3.03	3.10	3.02	3.10	3.11	3.20	....	....
2400	2.99	3.14	3.18	3.25	3.18	3.24	3.26	3.40	....	....
2700	3.16	3.30	3.32	3.44	3.32	3.48	3.48	3.56	....	....
3000	3.30	3.45	3.54	3.63	3.54	3.63	3.70	3.75	....	....
3150	3.50	3.64	3.70	3.78	3.75	3.85	3.85	3.85	....	....
3300	3.65	3.70	3.85	3.94	3.85	3.98	4.00	4.00	....	....
3450	3.80	3.80	4.01	4.08	4.00	4.08	4.10	4.08	....	....
3600	4.00	4.00	4.13	4.20	4.15	4.18	4.24	4.20	....	....
3750	4.12	4.12	4.24	4.28	4.30	4.29	4.34	4.33	....	....
3900	4.30	4.30	4.34	4.34	4.38	4.38	4.38	4.38	4.38	4.38

Machinery

The mean of these two values, 0.0014 inch, was considered to be the actual amount of force fit. It was necessary to know the amount of this force fit in order to make comparisons between the computed and observed amounts of increase of bore of the rotating wheel, since the wheel at zero speed is expanded somewhat.

Readings of the pointer were taken at various speeds as shown by the table, and the results plotted in Fig. 3, as mentioned. Owing to the fact that the wheel was forced on the shaft, the measured diameter of the wheel at zero speed is greater than the actual free diameter of the wheel. By methods given in the following, it was computed that the wheel was expanded by the force fit one-half of the difference in free diameters, the remainder being compression of the shaft. Hence the base line for increase in bore of the wheel, from the free condition, is the lower line of Fig. 3, which is 0.0007 inch below the base line for increase in bore from the actual initial value when on the shaft. The computed curve for the increase in bore for the free wheel at the various speeds is drawn in Fig. 3 beginning with the lower base line. At the speed at which the expansion of the free wheel is equal to the amount of the force fit, 0.0014 inch, the shaft is just released from its compression and wheel and shaft are of just the same diameter. For speeds beyond this point, the wheel expands exactly as if there were no initial force fit. The wheel is loose on the shaft by whatever increase in bore occurs beyond this point. The observed points are seen to

fit the computed curve very closely. For all speeds below that at which the wheel and shaft just touch, there is compression of the shaft and expansion of the wheel by the force fit, the amount being successively less as the speed increases. The effective force fit at any speed is the difference between the force fit at rest, and the expansion of the free wheel at the given speed. The effective force fit is, therefore, the difference between the dotted curve and the upper horizontal line. As shown later, when there are different amounts of force fit with a given wheel and shaft, the expansion of the wheel is always a constant fraction of the amount of force fit. This

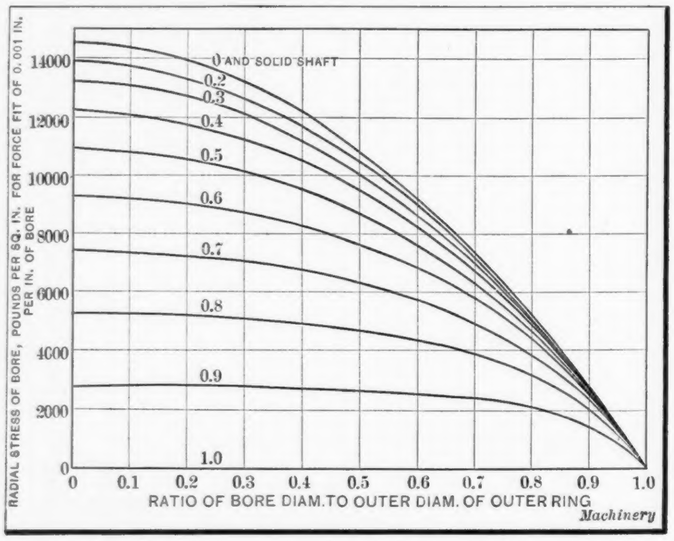


Fig. 5. Radial Stress at Bore with Allowance for Force-fit of 0.001 inch per inch of Bore—The Figures on the Curves denote Ratio of Diameter of Hole in Inner Ring (Shaft) to Diameter of Bore of Outer Ring (Hub)

is one-half in the present case. Hence the curve showing the increase in bore of the wheel, as the force fit is gradually relieved, is drawn halfway between the dotted curve and the upper horizontal line.

In the present case the amount of the force fit is comparatively small. It was originally intended to repeat the experiments with successively increasing amounts of force fit. The measuring apparatus was arranged so that it could be torn down and reassembled without change in the absolute initial value of the readings. This was done with the idea of actually

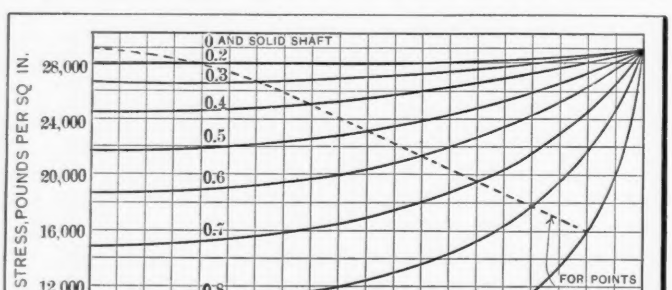


Fig. 6. Effective Tensile Stress at Bore of Outer Ring (Hub)

measuring the change in the initial bore of the wheel when put on the shaft with different amounts of force fit, giving curves in Fig. 3 which would start with successively greater amounts of force fit and meet the curve of a free wheel higher up. However, the results of the first experiment agreed so closely with the theory and everything was so obvious after study of the subject that no further experiments were made.

Design of Wheel subject to Increase of Bore by Centrifugal Stresses

The method used to prevent difficulty due to loose wheels is to force the wheel on the shaft with a force fit, or difference in diameters between wheel bore and shaft, greater than the computed amount of increase of bore at maximum speed. In some cases this has resulted in large amounts of force fit requiring very heavy pressures for forcing. Special material is necessary for the bushings between the wheel and the shaft. However, all of these points have been successfully met and ill effects due to loosening of the wheels wholly eliminated.

In some cases the wheel hubs do not fit along their entire length but only in places. The radial pressure when the fit occurs for only a short distance is obviously increased by the ratio of the total length of hub to the actual length of the fit. The numerical values of this radial pressure on the bushings come to very high figures in many cases. Of course, some relief is offered by the fact that this pressure is pure compression and that the metal of the bushings is constrained on nearly all sides so that the resistance to flow is considerable. Under such circumstances much higher values of compression stress can be used than when there is no resistance to the deformation which the compression tends to cause. There is reason to believe that in the ideal case of a piece subject to pure compression in every direction, there would be no failure even with an infinitely large stress. It is to be remarked that when the force fit is just sufficient to prevent loosening at full speed and the shaft is solid, the

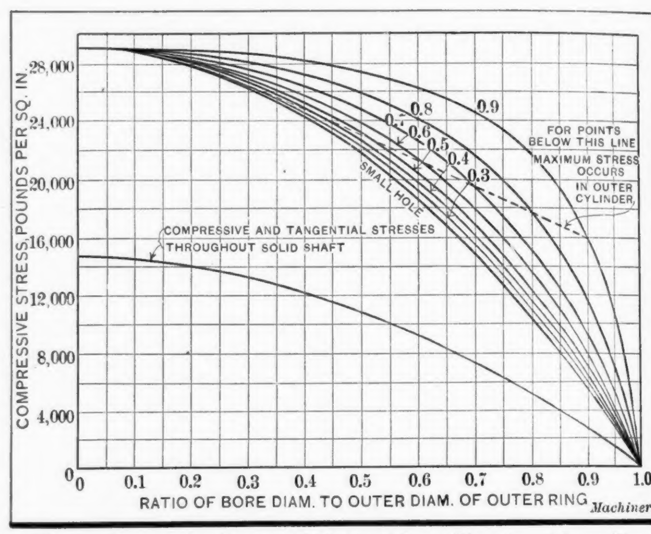


Fig. 7. Compressive Tangential Stress at Inner Diameter of Inner Ring (Shaft)—Values given are Maximum Effective Stresses in Inner Ring

effective stress in the hub due to the force fit at rest, is exactly equal to the stress at full speed.

Computation of Force and Shrink Fits with Steel

A wheel hub is affected by the stresses imposed only for a very short distance outward, so that the nature of the outer portion has little or no influence. The condition near the hub in a flat disk with an outer diameter only ten times the diameter of the bore is practically the same as in a disk with an infinitely large outer diameter. We, therefore, consider only the case of a ring forced upon another ring of equal axial length. We estimate the outer diameter of the outer ring so as to make it equivalent, so far as expansion is concerned, to a given wheel of any shape. For instance, for a solid wheel comparatively thin at the outer portion, we would estimate the equivalent flat disk to have one-half or one-third the diameter of the wheel. For a wheel with spokes, we have little more than the hub only. Owing to the comparatively slight influence of the parts of the rings furthest from the fit, a considerable error in estimation of the diameters of the equivalents will cause a comparatively small error in the results. Figs. 4, 5 and 6 give amount of expansion and stresses in an outer ring or hub pressed or shrunk on an inner ring or shaft.

The difference in the free diameters is called the force fit, which we will denote by X. When the hub is in place on the shaft and there is no rotation, it is expanded by a certain amount F'. The shaft is also compressed by a considerable amount. The sum of the increase of hub bore F' and the compression of the shaft is evidently the amount of the force

fit. Fig. 4 gives values of $\frac{F'}{X}$, the fraction of the force fit which the hub expands.

Fig. 5 gives the radial stress at the bore of the hub, which is also the stress at the outside of the shaft, as well as the pressure per square inch between hub and shaft when there is actual contact for the full length of the hub. Fig. 6 gives the maximum effective stress at the bore of the hub. This is the greatest stress in the system unless the shaft is hollow and relatively thin. Figs. 5 and 6 are for a force fit of one mil per inch of bore. Stresses for other values are in proportion. The abscissas of these figures give the ratio of the bore to the outer diameter of the hub. The upper curve in each of these three figures is for a solid shaft or one with a small hole and the other curves are for rings with various sizes of holes. When the abscissa is zero the outer diameter of the hub is infinitely large as compared with the bore. The curves are nearly horizontal for a considerable distance in this region and the results for an outer diameter ten times the diameter of the bore, that is, a ratio of 0.1, are almost the same as for an infinite outer diameter. The values for an outer diameter five or three times the diameter of the bore change but little.

Similarly, as will be seen by noting the curves for the various values of the ratio of the diameter of the hole in the shaft to the shaft diameter, the hole has but little influence unless it is comparatively large. The usual case of a shaft with a comparatively small hole is practically equivalent to a solid shaft. As will be seen by a study of the curves, the cases where the diameter of the hub is seven times the diameter of the bore, giving a ratio of 0.14, and where the hole in the shaft is 0.3 of the shaft diameter, give very nearly the results of any usual case. Hence, for usual cases the hub bore expands about 0.6 of the amount of the force fit and for a force fit of one mil per inch of bore the radial stress is about 13,000 pounds per square inch and the effective tangential stress is about 27,000 pounds per square inch. For a solid shaft, however, the maximum effective stress is 29,000 pounds per square inch for a force fit of 1 mil per inch of bore, regardless of the character of the wheel or hub. The stress for other amounts of force fit is in proportion.

Force fits of 1 mil per inch are, therefore, about as large as will give no permanent set of the hub for steel and a solid shaft. Force fits up to about 1½ mil are frequently used. These give some set of the fibers very near the bore. This set is almost entirely eliminated, however, by the elastic force of the outer fibers if the hub is ever removed from the shaft. Fig. 7 gives the maximum stress (at the inside) in the shaft or inner ring. This is usually less, but for a relatively thin ring may be greater, than the stress in the hub. A solid shaft has a stress one-half as great as one with a small hole.

A rational expression for the force in pounds required to press the hub on the shaft is

$$0.12\, dlS_r$$

where l is the length; d, the diameter of bore of the hub in inches; and S_r the radial stress at the bore found from Fig. 5. The coefficient 0.12 was obtained from actual tests and gives a coefficient of friction of 0.038. For a force fit of one mil per inch of bore, the forcing pressure is about 1560 pounds per inch of bore and per inch of hub length. The forcing pressure, of course, varies widely on account of the influence of surfaces and lubricants. The formula gives an average value.

* * *

The ordinary carpenter's level is not commonly regarded as an instrument of precision, but it is nevertheless more sensitive to variations in the level of planes than many mechanics suppose. The bubble of a good carpenter's level indicates variations of level in the ratio of four to one to the foot. Thus in a length of one foot a change from level of 1/64 inch should change the position of the bubble in the glass 1/16 inch. The highest grade precision levels magnify variations from a level plane thirty-two times. Hence a precision level one foot long should indicate a change of height of 0.0001 inch at one end by a bubble movement of 0.032 inch, an amount easily seen with the naked eye.

SECTION MODULI FOR RECTANGLES*

BY KARL E. BARRETT†

The tables presented in the current Data Sheet Supplement give the strength moduli for various sizes of rectangular sections which the writer originally compiled for his own use. These tables have drawn forth considerable comment among fellow designers, and on this account the idea of presenting them to the readers of MACHINERY suggested itself.

In designing, the problem of determining the required size of a rectangular member to carry a given load frequently arises. Evidently such a member can be of different shapes and still possess the necessary strength for the intended purpose. The method of using the tables in the supplement can be best illustrated by an example. A cast-iron beam is required to withstand a bending moment of 10,000 inch-pounds. Taking the ultimate strength of cast iron in flexure as 25,000 pounds per square inch, and dividing this value by the factor of safety of 10, which is used in the case of variable loads gives a working fiber stress of 2500 pounds per square inch. The strength modulus Z of the required section is found from the equation

$$\frac{25{,}000}{10} = \frac{10{,}000}{Z}$$

from which the strength modulus of the section will be seen to equal 4. Reference to the tables will show that the designer has a choice of six different sections of the following sizes:

3/8 by 8 inches; 7/16 by 7½ inches; 1/2 by 7 inches; 1 3/16 by 4½ inches; 1½ by 4 inches; 2 11/16 by 3 inches.

Several advantages are secured from the possibility of making this selection. These may be briefly enumerated as follows: 1. If one dimension is limited by the available space, the designer can tell at a glance what the second dimension must be to give the section the required strength modulus. 2. If the existing conditions do not limit either the width or depth, a choice of sizes can be made which will enable the most satisfactory shape to be used. 3. It will also be readily understood that the use of these tables saves a lot of time as compared with cut and try methods which would otherwise be necessary in proportioning a given member.

The tables were compiled from the equation for the section modulus of a rectangle. The section modulus for a rectangle equals $\frac{WD^2}{6}$, where W is the width of the section and D its depth. The results have been carried out to two decimal places in all cases, although in the case of sections deeper than 5 inches, this is really unnecessary. It will be seen that for the larger sections, the modulus increases by increments of 0.2 or more for every increase of 1/16 of an inch in the width of the section.

The writer has used these tables constantly in the designing room of E. & T. Fairbanks & Co., scale manufacturers, where their use has been the means of effecting a material saving in time and labor.

* * *

The moving picture machine is being applied to some interesting purposes other than mere amusement. It is being used successfully in scientific studies of motions required of workmen in doing work. Frank B. Gilbreth, well known as a scientific management expert, has applied the moving picture machine to motion study in the New England Butt Co.'s plant in Providence, R. I. The workman goes through the normal cycle of operations before the moving picture machine. In the same view is a clock having one hand only that shows plainly in every picture. The clock hand makes one revolution in six seconds, and intervals as short as one-thousandth minute may be noted, if required. The moving pictures obtained may be studied at leisure and the time of every movement accurately computed by reference to the clock dials at the start and finish. The advantage of consecutive and definite time records of all movements, both in detail and in the aggregate, is obvious to those familiar with the difficulty of obtaining accurate time studies of work being done.

* With Data Sheet Supplement.

† Address: Care of E. & T. Fairbanks & Co., Sherbrooke, Quebec, Canada.

GRAHAM MFG. CO.'S PRODUCTION LISTS

Production lists are considered essential in all modern manufacturing shops, but on account of the trouble incident to their preparation and upkeep they are often regarded in the light of a necessary evil. At the shops of the Graham Mfg. Co., Providence, R. I., manufacturers of drill speeders, a production list system is in vogue which requires a minimum of work for its maintenance. Fig. 2 shows a fac-simile of one of the lists which is used in the production of their No. 2 drill speeder. A zinc engraving was made having the name of the firm, a border and division lines, the numbers for the parts from 1 to 36 at the left side, and the headings for the columns. By printing 9- by 12-inch sheets of "Archive" bond paper with this engraving it became a simple matter to fill in the drawing numbers and other necessary data on the blueprint. No tracings are necessary as this bond paper is readily blueprinted through. By the use of item numbers, it is easy to refer to the different parts quickly when talking over the telephone or writing.

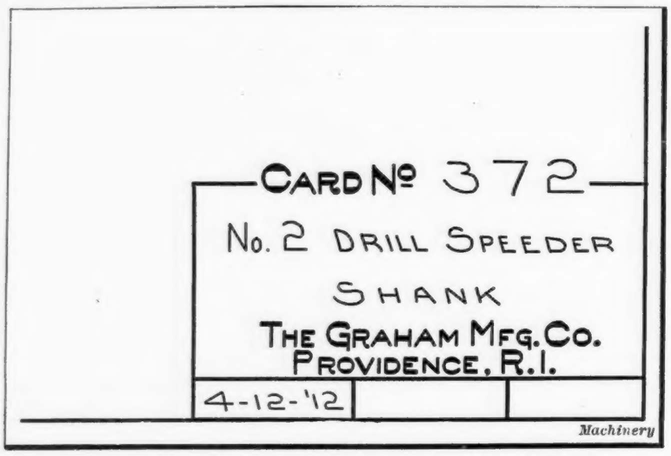


Fig. 1. Corner Form used on Drawings. Usual Margin Lines are omitted

Another interesting feature of the Graham Mfg. Co.'s production lists is the identification sketches which are shown at the right of each part description. These little sketches, which are made free-hand, serve to identify the part quickly when running down the list or when checking up any line of the list. The dimensions used in connection with the identification sketches are not intended to be worked to, but simply serve to give a general idea of the proportions of the piece. This feature of the production list is a great help to a new workman, who is less likely to make mistakes when identification sketches are used with each item of the list.

In connection with the general drawing system of the Graham Mfg. Co. it is interesting to note that all drawings are kept to standard sizes of 9 by 12 inches, 12 by 18 inches, and 18 by 24 inches. No border lines are used around the drawings, but they are made with merely a corner outline having the card number, title of the drawing, firm name, date, etc., as indicated in Fig. 1. By the elimination of the border lines a larger working space on the drawing is secured, and lines and figures may be run very close to the edge of the paper and still look well. In addition, when cutting blueprint paper the exactness required for bordered sheets is not necessary, and if sections of any print must be sent outside of the shop for estimates there are no border lines to disfigure such sections. One drawing is provided for each distinct piece, although there may be small screws or pins thereon, all of which are itemized upon the production list. Thus, referring to Fig. 2, it will be seen that on drawing 372 there are three items. This method of making production lists has saved considerable trouble and expense.

C. L. L.

* * *

An address made recently by James J. Hill before the Railway Business Association in New York on the need of greater railway facilities and terminals, has attracted widespread attention. What Mr. Hill said regarding the need of larger terminals is undoubtedly true—if our railroads continue to handle freight as they do now. But there is the possibility of revolutionizing the present methods with great consequent improvement in service and lessened need of large terminals. The need for large terminals arises from the fact that freight is not promptly unloaded as soon as it reaches its destination. If the railroads fully filled their function as transporters of freight, they would not stop with it at a great freight yard, but would unload it and deliver the smaller lots by wagon to the consignees, as is done in England and other European countries. No doubt if the influence of the express companies had not paralyzed the natural development of transportation, we would not now have in vogue the unnatural and inefficient methods of handling freight. The fact that the average mileage of a freight car is only twenty-four miles a day is proof that the greater part of its possible active earning capacity is wasted standing on sidings and in terminals. To greatly increase terminal capacity will be only to add enormously to the debt that American railroads stagger under and which is the one great cause of inefficient operation.

THE GRAHAM MFG. CO. PROVIDENCE, R. I.

PAGE — No. 2 DRILL SPEEDER — PRODUCTION LIST

Item	Drawing	Patt.	No. per Mach.	Mat'l	Piece	Remarks	Identification
1	372	--	1	Spc. Steel	Shank		
2	372	--	1	M.S.	Shank Cotter Pin for Oil		#13-3/32 × 3/4
3	372	--	1	T.S.	Shank Gear Key Ball		1/8 Diam
4	373	--	1	M.S.	Shank Gear	Case Hard.	16P 28T
5	344	--	1	M.S.	Shank Adjustment Nut, Upper	Case-Hard.	
6	344	--	1	M.S.	Shank Adjustment Nut, Lower	Case-Hard.	
7							
8							
9	370	370	1	C.I.	Body, Upper Half		
10							
11	371	371	1	C.I.	Body, Lower Half		
12							
13	374	--	1	Sr.St.	Spindle		16T 16P
14							
15							
16							
17	375	375	1	Bronze	Spindle Bushing		
18	375	--	1	M.S.	Spindle Bushing Adj. Screw		3/8 × 13/16 C-H
19	None	--	1	Stock	Spindle Thrust Ball Bearing 1/2"-#8	Am. Ball Co. Std Roll B. Co.	1 3/32 × 9/16 × 1/2 Hole
20	376	--	2	M.S.	Intermediate Pinion		1 1/8 Dia.
21	377	377	2	C.I.	Intermediate Gear		
22							
23							
24	378	--	2	M.S.	Gear Stud	Case Hard.	
25	378	--	2	M.S.	Gear Stud Nuts	Case Hard.	7/16 - Hex. St'd
26	378	--	2	M.S.	Gear Stud Oil Cotter Pins		#13 - 3/32 × 3/4
27							
28	379	--	1	C.R.S.	Stop Rod		
29		--	1	M.S.	Stop Rod Set Screw		
30	--	--	1	Br.	Name Plate		
31	--	--	1	Stock	Chuck Jacobs #2A, (3/8") Recess 1 3/32 Dia. 3/16 Deep		
32							
33	--	--	—	--	Star Enamel, or Jap-a-Lac,	2 Coats	
34	380	—	—	—	General Drawing		9" × 12"
35	None	—	—	Wood	Packing Box 3 1/2" × 5 1/2" × 10"	3/4 Stock	
36							

Fig. 2. Form of Production List used by Graham Mfg. Co.

FORMULAS FOR SPIRAL GEAR COMBINATIONS

BY L. G. ZESBAUGH*

The following gives useful formulas for finding the diameters and angles of spiral gears for cases where the distance between centers of the shafts, speed ratio and approximate diameter ratio have been assumed.

Let D_1 = diameter of driver;
D_2 = diameter of follower;
S_1 = speed of driver;
S_2 = speed of follower;
P = diametral pitch;
x = angle of teeth of driver with its axis;
N_1 = number of teeth in driver;
N_2 = number of teeth in follower.

The method of procedure is shown below.

Assuming trial values for D_1 and D_2, an approximate angle is derived from the formula

$$\frac{D_2S_2}{D_1S_1} = \cot x \qquad (1)$$

Find, by trial, the number of teeth for each of the gears which will most nearly balance the formula

$$\text{Twice distance between shafts} = \frac{N_1}{P\cos x} + \frac{N_2}{P\sin x} \qquad (2)$$

Balance Equation (2) by correcting the sines and cosines until the exact value of x is found.

Then

$$D_1 = \frac{N_1}{P\cos x} \qquad (3)$$

$$D_2 = \frac{N_2}{P\sin x} \qquad (4)$$

Application in a Practical Problem

Considering a case in which the distance between centers is 4.125 inches, the speed ratio of the driver to the follower 2 : 1, and the ratio of $D_1 : D_2$ about 9 : 8. It is required to find the diameters and angles of the teeth of the spiral gears.

Substituting known values in Equation (1), we find an approximate value of cotangent x as follows:

$$\frac{D_2S_2}{D_1S_1} = \frac{8 \times 1}{9 \times 2} = 0.4444 = \cot 66 \text{ degrees (approximately.)}$$

We find that 14 and 28 teeth will best balance Equation (2). Substituting these numbers of teeth and the functions of 66 degrees in this equation, we have

$$\frac{14}{8 \times 0.4067} + \frac{28}{8 \times 0.9135} = 8.134$$

Subtracting, $8.250 - 8.134 = 0.116$

We see that the angle of 66 degrees introduces an error of 0.116 inch for twice the distance between centers of shafts. This shows that 66 degrees is not exactly the required angle. Trying 66 degrees 50 minutes, we get

$$\frac{14}{8 \times 0.3934} + \frac{28}{8 \times 0.9194} = 8.254$$

Subtracting, $8.254 - 8.250 = 0.004$

We see that 66 degrees 50 minutes is very close to the required angle, as the error for twice the distance between the centers of the shafts is now only 0.004 inch; trying an angle of 66 degrees 48 minutes, we get

$$\frac{14}{8 \times 0.3939} + \frac{28}{8 \times 0.9191} = 8.25$$

The angle of 66 degrees 48 minutes gives exactly the required distance between centers. We can now use this angle in determining the required diameter for the driver and follower by substitution in Equations (3) and (4).

$$D_1 = \frac{N_1}{P\cos 66^\circ\, 48'} = \frac{14}{8 \times 0.3939} = 4.442 \text{ inches}$$

$$D_2 = \frac{N_2}{P\sin 66^\circ\, 48'} = \frac{28}{8 \times 0.9191} = 3.808 \text{ inches}$$

By reference to a table of natural functions, we find that sine 66 degrees 48 minutes equals cosine 23 degrees 12 minutes, and this determines the angle of the teeth in the follower as 23 degrees 12 minutes.

* Address: Care of Rockford Engine Works, Rockford, Ill.

* * *

STANDARDIZING DRAFTING-ROOM AND SHOP TERMS

There appears to be a demand for a more definite understanding of certain drafting-room and shop terms, among which are: "tolerance," "working tolerance," "permissible tolerance," "necessary tolerance," "clearance," "working clearance," "allowance," "working allowance," "running fit," "sliding fit," "snug fit" and "finish." Confusion has resulted from the loose manner in which these terms have been used in technical papers, hand-books, etc. Now in the writer's opinion, there are three terms which adequately cover the meaning conveyed by the preceding list. They are "finish," "tolerance" and "clearance."

The term "finish" implies the final touches or elaboration that is given to the work, and should not be confounded with the accuracy or final dimensions that are required. The class of finish required should be specified on the drawing. For instance: polish, buff, paint, etc., according to the appearance that is desired. The term "tolerance" implies the amount of deviation from the specified dimensions that is permissible. Neither all mechanics nor all machines are capable of turning out work with the same degree of accuracy, and to allow for such inaccuracy, a certain degree of tolerance is allowed although it is not desirable. This deviation from the specified dimensions must be expressed in the form of an exponent, of the proper sign, as ±, —, or +, to the actual dimensions of the article. "Clearance" is used to denote the space between adjacent parts, whether it is merely to avoid interfering or to signify the different classes of fits previously mentioned. The clearance allowed between different parts is governed by the condition under which such parts are to work, the amount being left to the judgment of the designer. Clearance should be taken into account when giving the actual dimensions of individual parts, and should always be indicated on the drawing as the actual size of the part and not as an exponent as in the case of tolerance.

In specifying tolerance and clearance, care should be taken to make sure that the parts can be properly assembled. The importance of this measure will be made apparent by the following example: A shaft for a 2-inch hole should be specified as $1.997^{-0.002}$ inch, polish. This signifies that the 0.003 inch clearance is the space between the shaft and the hole which the designer considers necessary for good running, minus a tolerance of 0.002 inch which will be allowed for inaccuracy in workmanship; the work is then to be finished with a polished surface. The size of the hole to carry the shaft would be specified as $2.0^{+0.002}$ inches. These dimensions refer to diameters in both cases. It is true that if the workmanship is poor, there will be an actual clearance of 0.003 inch + 0.004 inch = 0.007 inch between the shaft and the hole. This error can be reduced by making the specified tolerance less, or in other words by requiring more careful and accurate workmanship. The practice of making drawings which specify the exact amount of clearance between different parts and the amount of tolerance is to be advocated. Where such a practice is followed, there can be no controversy when the work comes up for inspection, because everything is plainly stated and there is no opportunity for misunderstandings to arise from the use of such terms as "running fit," "necessary tolerance," "working clearance," etc. S.

* * *

A booklet entitled "Machine Tools in Latin America," will be issued shortly by the Bureau of Foreign and Domestic Commerce, Washington, D. C. It comprises a series of consular reports with a valuable list of firms and individuals in Latin-American countries who use or sell machine tools. Considerable attention is also given to sales methods, credit terms, etc. There seems to be an increasing demand for machine tools in these countries, especially in connection with railway repair work.

DESIGNING STEEL TOWERS FOR WOOD TANKS—3

A COMPLETE ANALYSIS OF THE STRESSES IN THE TOWER STRUCTURE

BY EDMUND B. LA SALLE*

Determination of Loads in Bracing

We have now proportioned the columns and can turn our attention to the diagonal rods and struts or girts as we will call them, as that is the usual name as applied to towers. For this purpose we will use graphical statics, constructing a frame diagram of the tower to represent the dimensions given to a convenient scale, as shown in Fig. 12. The initial force in the diagram when worked out according to H (preceding installment) is:

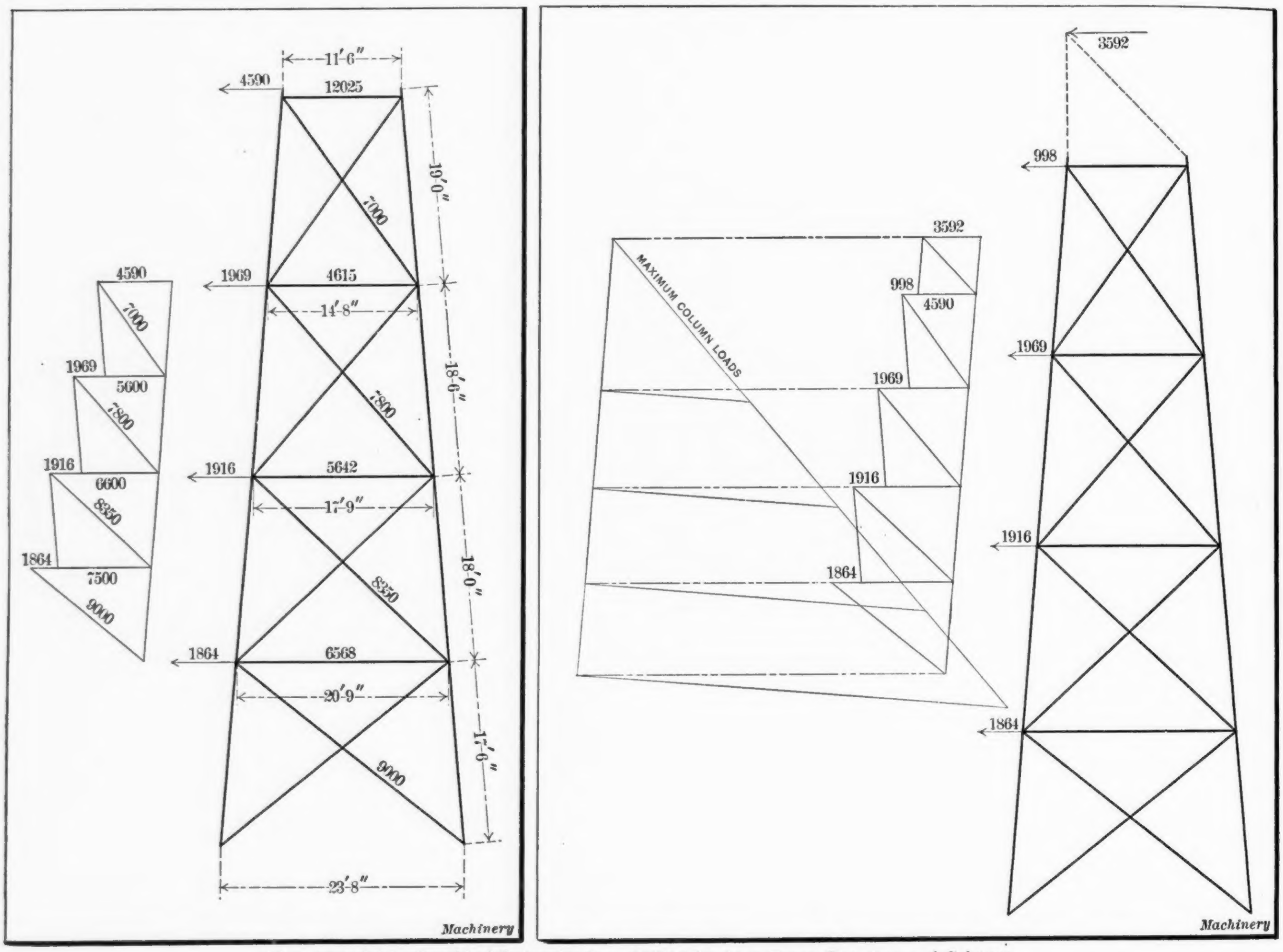
$$\frac{7184}{2} + \frac{19 \times 210}{4} = 4590 \text{ pounds.}$$

From this we subtract one-half the value obtained under J which is:

$$\frac{19 \times 210}{4} = 998 \qquad \frac{998}{2} = 499, \text{ say } 500 \text{ pounds.}$$

$$12{,}525 - 500 = 12{,}025 \text{ pounds load in top girt.}$$

The reader will probably have noticed that the stress diagram Fig. 12 is slightly different in appearance from the one shown in the first installment. This is due to adding the loads J at each corresponding point instead of on the load line at the top as before. The method used in the present discussion is somewhat simpler and easier to understand. The letters are also omitted as the diagram can readily be followed without them.



Figs. 12 and 13. Graphical Determination of Wind Loads in Tower Structure and Columns

The wind concentrated at the second girt from the top, according to J is:

$$\frac{(19 + 18.5) \times 210}{4} = 1969 \text{ pounds.}$$

The force for the third girt is:

$$\frac{(18.5 + 18) \times 210}{4} = 1916 \text{ pounds.}$$

The force for the bottom girt is:

$$\frac{(18 + 17.5) \times 210}{4} = 1864 \text{ pounds.}$$

With these forces worked out construct the stress diagram as shown and scale off the loads. From the girt loads subtract one-half the values calculated by J to get the actual loads in the girts. For the load in the top girt we refer to I which gives a value of:

$$\frac{401{,}415 - 20{,}500}{48} + 4590 = 12{,}525 \text{ pounds.}$$

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Graphical Method for Finding Column Live Load

In Fig. 13 is shown a diagram from which we can get the wind loads in the column directly, instead of calculating as previously explained. Of course the first method is more accurate, but considerably longer. There is one valuable feature in the graphical method, and that is that we can get the column wind load in any panel by scaling the diagonal column load line. To draw the diagram, lay out the frame diagram as before. On top of the frame diagram, construct a triangle. The vertical line of the triangle is drawn to a height equal to the distance of the center of gravity of the tank wind, which coincides with the center of the tank. The diagonal is drawn from the top of the right-hand post to the top of the vertical line. This gives us the point of application of the tank wind as regards the tower. Next, draw the top line or initial load of the stress diagram equal in length to half the tank wind. In this case, we do not add one-half the top panel wind, as in the other diagram, that being added later. Now

draw the right-hand line of the diagram of indefinite length and parallel to the left-hand post of the frame diagram. From the left-hand end of the initial load line, draw a diagonal line parallel with the diagonal line of the tank wind triangle on top of the frame diagram. Extend this line to intersect the column load line, as shown, and at the intersection draw a horizontal line of indefinite length. From the left-hand end of the initial load line, draw a slanting line parallel with the column load line and intersecting the hoizontal line just drawn. We now have a polygon of forces which represents the reaction at the top of the columns due to the overturning moment of the wind on the tank. We next add the wind on the upper half of the top panel to the line forming the bottom of the polygon, as represented in Fig. 13 by 998 pounds. That force then becomes 4590 pounds which the reader will notice is the same as the initial force in the previous diagram, Fig. 12. We have done nothing else here but add the polygon representing the reaction on the columns, due to the overturning moment of the wind on the tank, to the diagram Fig. 12, in order to represent the addition to the column load line of the reaction of the tank mentioned above. The shape of the polygon is governed by the location of the center of gravity of the tank, as represented by the triangle which was added to the frame diagram.

Starting with the horizontal force of 4590 pounds, we can now complete the diagram as we did in Fig. 12. The lines will all scale the same except the column load line which, of course, will be longer. If we now multiply the amount we get by scaling the column load line by 1.4142, we will have the maximum column wind load, as previously calculated for the wind blowing diagonally across the tower. The line gives the true column wind load when the wind is acting parallel with the sides or trusses of the tower, but as that is not the most severe condition, we do not use that value. In order to scale the maximum column wind load in any panel, we project the panel points and the column load line to one side of the diagram as shown. Then draw a line parallel with the column load line and erect a perpendicular at its base equal in length to the column load line. Join the ends of these two lines by a diagonal. This diagonal, when scaled, will give the maximum live load in the column due to the wind. If we now erect a perpendicular at each panel point to intersect the diagonal line, as shown, we can scale the column live load in each panel by measuring from the left-hand end of the diagonal in each case to the point in question. The scaled live load, added to the dead load, gives the total column load, and it should check closely with the computed load if the diagram is properly drawn.

Size of Girts

The maximum length of girt recommended gives a value of 175 for $\frac{L}{R}$. Some specifications call for 150 for the factor $\frac{L}{R}$, but in that case the girts become so heavy that they are out of proportion to the columns, when the columns are proportioned according to the two formulas given in the preceding installment:

$$\text{Strength per square inch} = 17{,}100 - 57\frac{L}{R} \qquad (1)$$

$$\text{Strength per square inch} = 16{,}000 - 70\frac{L}{R} \qquad (2)$$

Of the two formulas, the writer favors the second as it cuts off faster, *i. e.*, it grows safer as the columns or girts grow longer. In regard to the maximum length of the columns, it may be said that in no case should they exceed a length that makes $\frac{L}{R}$ over 125. Nearly all girts are made of two unequal leg angles placed one above the other with the longer leg horizontal (as shown on page 371 of the January, 1912, issue of MACHINERY), and connected by batten plates at the ends and by flat lacing bars between the plates, similar to a standard channel column. The top girt in this case can be placed so that its center line is 9 inches below the top of the column, and the center-to-center length then becomes 139½ inches. The required radius of gyration is $139.5 \div 175 = 0.80$.

The smallest angles it is practical to use are two 3 by 2 by ¼ inch. The radius of gyration about the axis parallel with the small leg or flange is 0.97 which is a little more than is required.

$$\frac{L}{R} = \frac{139.5}{0.97} = 144.$$

According to Formula (2) this gives a value per square inch of 5920 pounds for the strength of the girt; $5920 \times 2.38 = 14{,}090$ pounds, total strength of the girt.

We will now try the formulas derived from the results of U. S. Government tests (page 455, February number), and see what safety factor the girt has. As the girts are fastened to the columns by means of rivets or bolts, we will call them pin-ended compression members, and use $30{,}000 - 200\,(144 - 125) = 26{,}200$ pounds.

$26{,}200 \times 2.38 = 62{,}356$ pounds, ultimate strength of girt; $62{,}356 \div 12{,}025 = 5.18$, actual safety factor.

It is a good plan to have a large safety factor for the top girt, as this member receives a heavy and constant load, while the other girts do not receive a constant dead load, but only the varying load due to the wind.

The center-to-center distance of the second girt from the top is 14 feet 8 inches = 176 inches; $176 \div 175 = 1.00$, required radius of gyration.

The nearest size to this is two 3½ by 2½ by ¼ L-sections. They have a radius of 1.12. It is best to keep the number of sizes used as small as possible, and to stick to the sizes most commonly used. The reader will find that there are sizes in other sections that come nearer to the required radius of gyration than those mentioned, but they are not so common and are therefore harder to get quickly when wanted. The sizes which will be considered are the ones generally used for tower girts.

$$\frac{L}{R} = \frac{176}{1.12} = 157.$$

This gives 5010 pounds as the strength per square inch; $5010 \times 2.88 = 14{,}429$ pounds, strength of girt.

This shows that the girt selected is somewhat too strong for the wind load, but it would not be advisable to use one making $\frac{L}{R}$ greater than 175. During erection, the girts are used as supports for the scaffolds, and sometimes a considerable weight is supported by them as beams; therefore, they should have a good factor of safety as far as the wind is concerned, and it will be found after a number of trials that a value of 175 for $\frac{L}{R}$ will give satisfactory results.

The third girt from the top has a length between centers of 17 feet 9 inches = 213 inches and $\frac{213}{175} = 1.22$, required radius of gyration. Two 4 by 3 by 5/16 inch L-sections have a radius of gyration of 1.27 and a cross-sectional area of 4.18 square inches.

$$\frac{L}{R} = \frac{213}{1.27} = 168.$$

This gives a strength of 4240 pounds per square inch and a total strength of $4240 \times 4.18 = 17{,}723$ pounds for the strength of the girt.

The bottom girt has a length of 20 feet 9 inches = 249 inches; $249 \div 175 = 1.43$, required radius of gyration. Two 5 by 3 by 5/16 inch L-sections have a radius of gyration of 1.61 and an area of 4.82 square inches.

$$\frac{L}{R} = \frac{249}{1.61} = 155.$$

This gives the strength of the girt a value of 5150 pounds per square inch and $5150 \times 4.82 = 24{,}823$ pounds, total strength of girt.

We have seen that for all girts other than the top one, we do not need to calculate their strength as regards the wind load, because that load is comparatively light, and when the

length limit giving 175 for $\frac{L}{R}$ is adhered to, the girts are always amply strong. This assertion applies to standard towers only, *i. e.*, to those with a column slant or batter of one inch per foot, and not to those having a large batter or other special features of construction. We should always be sure that the girts have a safety factor of at least 4, which can be ascertained by using any of the formulas derived from the tests. For girts we would use, as before:

$$S = 30{,}000 - 200\left(\frac{L}{R} - 125\right)$$

Size of Diagonal Rods

The diagonal brace rods come next into consideration. The best fiber stress to use for them is 12,500 pounds per square inch. The top rods have a load of 7000 pounds. Hence 7000 ÷ 12,500 = 0.56 square inch, required area.

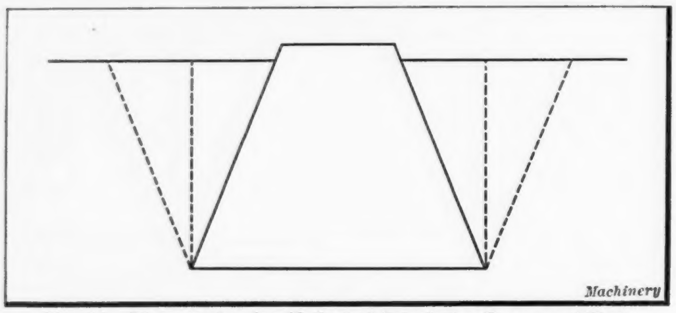

Fig. 14. Diagram showing Method of Calculating Pressure of Piers

If we do not want to upset the rods on the threaded ends, it will be necessary to use rods one inch in diameter. This size of rod will have a fiber stress of 12,750 pounds per square inch which is not seriously in excess of the specified limit. It is considered better practice not to upset the rods at the end, as when they are upset there is danger of their being burnt in heating. It is, however, more economical of material to upset them. In the upset rod it would require a $\frac{7}{8}$-inch diameter rod to upset to $1\frac{1}{8}$ inch. By the same method, using rods that are not upset, we will find that the next three sets of rods will have to be $1\frac{1}{8}$ inch in diameter, and have a fiber stress not exceeding 13,000 pounds per square inch. It is not advisable to exceed 13,000 pounds per square inch for the fiber stress. Now if the designer chooses he can also make the top rod $1\frac{1}{8}$ inch in diameter in order to have all of the rods alike, and simplify the work.

Size of Anchor Rods

The load in the anchor rods obtained according to *G* of the outline in the preceding installment was found to be 21,170 pounds. As two rods are used for a double-angle column, we divide the load by 2 and obtain 10,585 pounds in each rod. The fiber stress in the anchor rods should not exceed 13,000 pounds per square inch, as in the case of the diagonal rods, but 12,500 pounds is a preferable figure. Hence 10,585 ÷ 12,500 = 0.85 square inch, area at root of thread, which calls for a $1\frac{1}{4}$-inch rod.

Foundation Piers

The concrete piers are one of the most important details in tank tower construction, as the stability of the whole structure depends on them. The size of the base should in each case be proportioned to suit the class of soil on which the tower is to be located. When lack of definite information is at hand, we can assume 3000 pounds per square foot of soil as a safe bearing value. In the present case we have a total column load of 136,030 pounds and a maximum uplift on the anchor rods of 21,170 pounds. The complete load on the soil includes the column load, the weight of the pier and the weight of the earth on top of the pier as shown in Fig. 14. It would be rather difficult to tell what the actual effect of the earth on the pier would be, that is, how much it would increase the pressure on the soil. The writer has adopted the assumption that the weight due to the pier and soil is equal to a prism of the same height as the pier and with other dimensions equal to those of the base of the pier, having a weight of 140 pounds per cubic foot. Area of base × height × 140 = load on soil due to weight of pier and earth. This added to the maximum column load is the total load on the soil. To arrive at the approximate size of the pier base, add 50 per cent to the column load and divide by 3000, or divide the column load by 2000; thus 136,030 ÷ 2000 = 68.02 square feet.

Taking the nearest greater 6 inches, we find the size of the required base to be 8 feet 6 inches square. A pier should not be made less than 5 feet deep in order to get below the frost line. We will call this one 6 feet deep and 3 feet square at the top, and then calculate its weight. The cubic contents of a pier of this shape equals

$$\frac{H}{3}(a^2 + b^2 + ab)$$

where
H = height;
a = side of top;
b = side of base.

Substituting in this formula gives:

$$\frac{6}{3}(9 + 72.25 + 25.5) = 213.5 \text{ cubic feet.}$$

At 140 pounds per cubic foot, the weight of the pier would be 29,890 pounds. The weight of the pier should at least equal the uplift on the anchor rods and in this case it exceeds it. We can now determine the unit load on the soil as follows: 8.5 × 8.5 × 6 × 140 = 60,690 pounds, weight of pier and earth; 60,690 + 136,030 = 196,720 pounds, total load on soil; and 196,720 ÷ 72.25 = 2723 pounds per square foot, pressure on soil.

This shows that our assumption of 50 per cent added to the column load was a trifle high. It will probably be found, if we revise our figures, that we can use a pier 8 feet square. Before we reduce the size of the pier we must first ascertain whether the weight of the proposed pier will equal the uplift.

$$\frac{6}{3}(9 + 64 + 24) = 194 \text{ cubic feet, volume of pier.}$$

194 × 140 = 27,160 pounds, weight of pier.
64 × 6 × 140 = 53,760 pounds, weight of pier and earth.

$$\frac{53{,}760 + 136{,}030}{64} = 2966 \text{ pounds per square foot, pressure on earth.}$$

We have now proportioned all the principal members of the tower to safely sustain the load to which they are subjected. The only thing that remains is for the designer to so design the splices and connections that they will develop the full strength of the members they connect. Of course the usual rules of structural engineering are to be followed in the present field of design.

* * *

One of our contemporaries relates the following story which illustrates very well the attitude of the "political" engineer: A mining-machinery salesman recently walked over to a city rock pit where rock for making roads was excavated and crushed. The drills in use there were manufactured by the company he represented, but were of extremely antique pattern. The young salesman, with characteristic enthusiasm, began to tell the engineer in charge of a very efficient one-man drill that was making a record for itself. He claimed that if the city would install the improved type, at least one-half the present force of men could be dispensed with. At this point the city official spoke up: "Young man," he said, "if you can give us a drill that will require more men to operate and make more jobs that aren't too hard, we'll be interested, but this new machine is not in our line."

* * *

The Society of Automobile Engineers has invited a party of members of the British Society of Automobile Engineers and the Society of Motor Manufacturers & Traders, Ltd., to make a visit to the United States in the spring. The visit will coincide with the annual summer meeting of the Society of Automobile Engineers. A number of automobile factories and factories engaged in the production of automobile parts will be visited and arrangements have been made for a three days' excursion on the Great Lakes.

AT THE AUTO SHOW—TRADE JOURNALS

"There are many interesting things at the auto show," said the editor, "and some that are not so interesting. One class of stands that I steer clear of as much as possible, is that of the auto trade journals."

"Why, that's strange, seeing that you are in the trade journal business yourself."

"Yes, I'm in the business, and that's why I feel sensitive about it. I don't want to feel ashamed, but I do every time I see the frantic methods they employ to get subscriptions. If an unsuspecting visitor stops momentarily to look at *Motor Mucker* or *Auto Bazoo*, a peroxide blonde or a callow kid will collar him and tell him that his everlasting salvation depends on taking a subscription right there and then.

"It's all right to go after business, and I believe in going after it as hard as anyone, but soliciting subscriptions from every passer-by at an auto show is poor policy. It cheapens the proposition and makes the publisher look like a piker. If his journal is worth reading, the people who want it and will be subscribers worth having, don't need to be lassoed, thrown and hog-tied before they'll subscribe. They'll come up all right, plank down their dollars and be glad of the chance. No Coney Island barkers are required to get subscribers who are really interested and who will be worth while to advertisers."

* * *

THE "STEEL-EATING" WORM

An interesting account of the "steel eating" worm is given in one of our contemporaries. About 1866, a number of workingmen employed in the various iron, steel and chemical works, in the district surrounding Haspe, in Germany, used to meet at certain intervals at a hotel to discuss subjects of general interest. At one of these meetings, the discussion gave one of the members an idea which resulted in the creation of the "steel-eating" worm. The editor of a newspaper in one of the neighboring towns was made the subject of the joke. The worm was manufactured from a piece of rubber tubing and was exhibited in a bottle half full of steel chips. The worm was filled with dilute hydrochloric acid, and when properly disturbed with a glass rod it would emit a drop of the acid, which, on attacking the scale, served to prove that the corrosion was due to a secretion of the worm, and that the oxides formed its food. The editor accepted the exhibit in good faith, and published an account of the alleged discovery, with the consequence that it reappeared in many other journals, and has since been reproduced at intervals.

* * *

At the Philadelphia & Reading R. R. shops in Reading, Pa., a novel method is employed for keeping the aisle space adjacent to the tracks which run through the shop clear. At the required distance which must be kept clear on each side of the rails, strands of wire are set into the floor flush with its surface, and held in place by small staples. These wires are called "dead lines" and it is much easier to impress upon the workman's mind that material must not be placed over these lines than to say that he must keep material a specified distance from the rails. During the day, the general foremen occasionally glance down these dead lines and thus easily ascertain if the aisles are properly cleared.

DIE FOR PIERCING RODS AND RIVETS

BY CORWIN LAMOREAUX*

In the factory where the writer is employed, folding sleds, door hangers and various other hardware specialties are made, which require one or more rivets or pins, principally of 5/16 inch diameter and varying from 5/8 inch in length up. There is a hole near one end of these rivets for a 1/8-inch cotter pin, which, in cases where accuracy and good finish are essential, is drilled in a simple jig adapted for the work. However, there

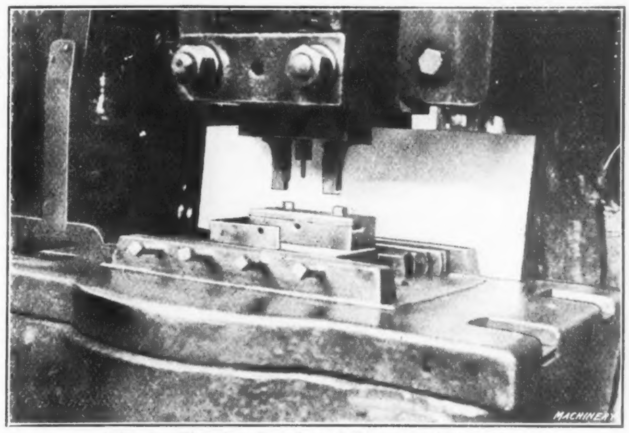

Fig. 1. Piercing Punch and Die mounted in Press

are a number of the articles which do not require a nicely drilled hole, and to reduce the cost of piercing the thousands of pieces that are needed, a die was designed to do this work in a punch press. This die is shown in Fig. 1 set up in the press ready for use; this illustration also shows the gage extending in front of the die. This gage is adjustable to accommodate pieces of different lengths, and locates the pin or rivet in the die so that the hole is pierced in the proper place. It will be noticed that the press is large for the light character of the work, but this is explained by the fact that it is neces-

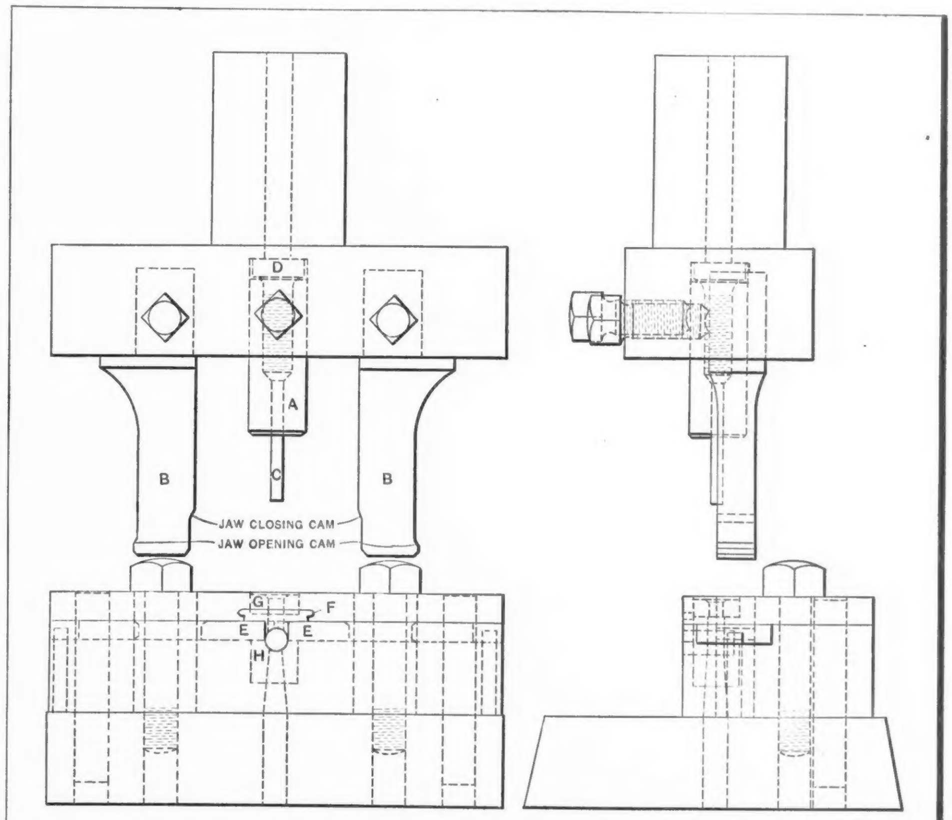

Fig. 2. Details of Design of the Rivet Piercing Punch and Die

sary to have a rather slow action to operate the die, in order to avoid upsetting and breaking the punches. The press shown makes about eighty revolutions per minute.

Fig. 3 shows the punch, die and gage in detail. In this connection, it might be of interest to state that an adjustable

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gage was originally placed at the rear of the die, consisting of a hardened screw bearing against the end of the pin being pierced. This arrangement was unsatisfactory, as the metal flowing away from the pressure of the punch pressed against the end gage and the reaction against the slender piercing punch caused it to be bent forward and broken. After adopting the present gage, there was no trouble from that source.*

Fig. 2 shows the details of construction of the punch and die. The punch-holder is made of machine steel and has the straight shank punch quill *A* and cams *B* inserted in it. The piercing punch *C* is made of No. 20 carbon steel drill rod inserted in the hardened and ground tool-steel quill *A*; the punch is backed up by the hardened tool-steel screw *D*. The drill rod punches are hardened to within 1/8 inch of the head, and are drawn to a blue near the top which gradually runs down to a brown color near the end. The jaws *E* are made of tool steel and are machined to fit the upper surface of the rivet closely; the plug die *H* fits the lower surface of the rivet, so that the latter is held in the opening between the jaws *E* and the plug die *H*. On the down stroke of the ram, the jaw-closing cams on the members *B* press the jaws tightly against the rivet, and on the up stroke, the opening cams spread the jaws apart. Two stop-pins *I*, Fig. 4, are provided at each end of the die to prevent the jaw from moving too far back. The tool-steel bushing *G* is provided to guide the punch and prevent it from buckling. The small tool-steel piece *F* keeps the rivet from bending upward and wearing the hole out of round. To make the work easier on the punch, the hole in the plug *H* is made about 1/32 inch larger than the punch.

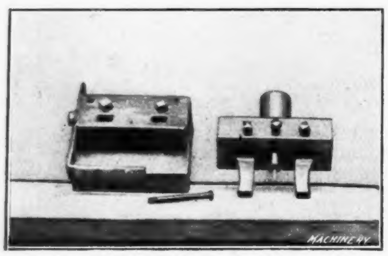


Fig. 3. Piercing Punch and Die and One of the Pierced Rivets

In operation, the rivet is placed in the hole in the gage and pushed into the die, the head of the rivet abutting against the gage; this provides for piercing the hole at the required distance from the head. From four to five thousand pieces have been pierced with one punch before bending or breaking, and as it is but a few minutes work to replace the punch, the cost is trifling. A saving of about 80 per cent in the cost of piercing the rivets was effected by the use of this device in place of the drill press, not to mention the convenience of quick production of parts for immediate use in the factory.

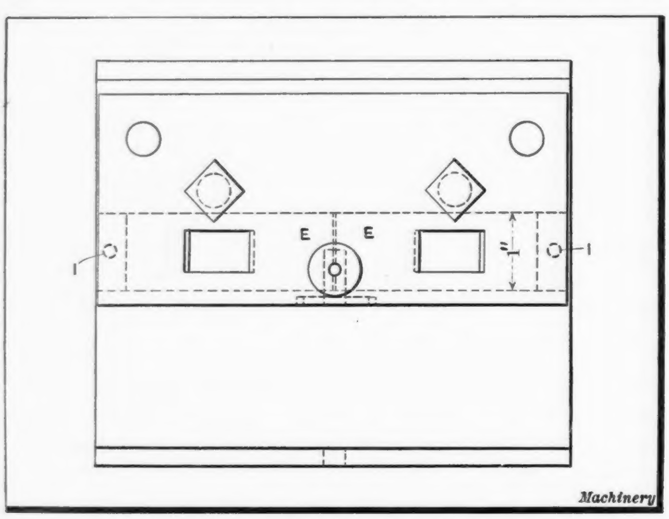


Fig. 4. Plan View of the Die

* * *

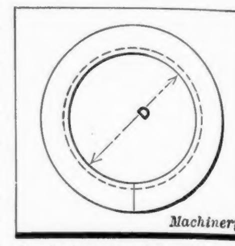
A demonstration has been given at Southport, in England, of a vacuum street sweeper brought out by a Sheffield firm. The machine, which is the invention of an Italian engineer, resembles an ordinary automobile, and is fitted with an apparatus producing a suction effect. It is claimed that the machine will sweep a road or street without raising any dust and without causing any damage to the surface.

LENGTH OF ANGLES BENT TO CIRCULAR SHAPE

BY R. H. CREVOISIE*

It is sometimes required to calculate the length of an angle-iron used either inside or outside of a tank or smokestack. The following formulas and table of constants can then be used to advantage.

Assume, for example, that a stand-pipe, 20 feet inside diameter, is provided with a 3 by 3 by 3/8 inch angle-iron on the inside at the top. The circumference of a circle 20 feet in diameter is 754 inches. From the table of constants we find the constant for a 3 by 3 by 3/8 inch angle-iron to be 4.319. The length of the angle then is 754 — 4.319 = 749.681 inches. Should the angle be on the outside, we add the constant instead of subtracting it; thus, 754 + 4.319 = 758.319 inches.



Angle-iron bent to Circular Shape

When a shell ring is made of several plates, use one length of angle-iron for every two plates in the shell ring. When, for instance, a stand-pipe is made up of four plates around its circumference, use an angle-iron consisting of two equal lengths. For splicing these angle-irons, a shoe is made from a plate 1/2 inch wider than the sum of the two legs of the angle, and 1/16 inch lighter than the plates in the ring to which this angle is riveted. This shoe is usually made long enough for three rivets in each angle.

TABLE OF CONSTANTS USED FOR CALCULATING LENGTH OF ANGLES BENT TO CIRCULAR SHAPE

Size of Angle	Constants	Size of Angle	Constants
1/4 x 2 x 2	2.879	1/2 x 3½ x 3½	5.235
5/16 x 2 x 2	3.076	3/8 x 4 x 4	5.366
3/8 x 2 x 2	3.272	1/2 x 4 x 4	5.758
1/4 x 2½ x 2½	3.403	3/8 x 5 x 5	6.414
5/16 x 2½ x 2½	3.600	1/2 x 5 x 5	6.804
3/8 x 2½ x 2½	3.796	3/8 x 6 x 6	7 461
1/2 x 2½ x 2½	4.188	1/2 x 6 x 6	7.854
1/4 x 3 x 3	3.926	3/4 x 6 x 6	8.639
5/16 x 3 x 3	4.123	1/2 x 8 x 8	9.949
3/8 x 3 x 3	4.319	3/4 x 8 x 8	10.734
1/2 x 3 x 3	4.711	1 x 8 x 8	11.520
3/8 x 3½ x 3½	4.843	....	......

Machinery

* * *

The Walker Magnetic Chuck & Grinder Co., Worcester, Mass., long ago found that there is a marked difference in the action of a planer tool and a face milling cutter as regards the chipping of castings on the outside edges. The company has for years made magnetic chucks, the faces of which are cast-iron grids or spiders with various arrangements of the poles. The space between the poles is filled in with non-magnetic soft metal of the nature of babbitt. The castings are roughed on a planer fitted with an Adams milling head carrying an inserted-tooth face milling cutter. This tool sweeps off the rough surface without breaking out the edges, which is a very necessary requirement. When the chuck is assembled and the filling metal is poured and peened in place, a finishing cut is taken on a planer, using a planer tool. Notwithstanding the fact that the cut is a thin finishing cut and the edges are supported somewhat by the soft metal in the slots, the edges will break out unless the planer tool is made with a shearing cutting edge. What is the cause of the difference in the action of the two tools as regards chipping the edges of the castings?

* * *

The annual per capita fire waste in the United States is \$2.51 as compared with 33 cents in Europe. The reason for this difference is partly to be found in the better construction of buildings and less carelessness in Europe. If the buildings of the United States were as nearly fireproof as those in Europe, the annual fire losses and the cost of prevention of fires could be reduced to one-fifth of what it now is.

* Address: Wickes Boiler Co., Canton, Ohio.

STEAM POWER PLANT PIPING DETAILS—2

LAY-OUT OF STEAM PIPING AND CONNECTIONS

BY WILLIAM F. FISCHER*

Having decided upon the general arrangement of the steam piping system best suited to the lay-out of the plant and apparatus, the designer should turn his attention to the important details of the piping and connections. The design of a boiler header and its connections is not such a simple problem as it at first appears, for there are many details of importance to be taken into account. In most cases of bursting steam mains and fittings, the trouble has been traced to faulty design and incorrect methods of erection, rather than to defects in the material of the piping system. High-pressure piping, valves and fittings are, as a general rule, designed to safely withstand a pressure of from six to twelve times the working pressure, or the pressure they are to be subjected to in actual service; therefore, it rests with the engineer or designer to see that the piping system is properly arranged and carefully erected, so that no part will be unduly strained in service, either by expansion and contraction, water-hammer, or sagging of the pipes due to incorrect methods of supporting them. In the following examples, taken from practice and experience with the design and erection of numerous piping systems, the writer will try to give a general idea of correct and incorrect methods employed in the lay-out of steam piping between the boilers and prime movers.

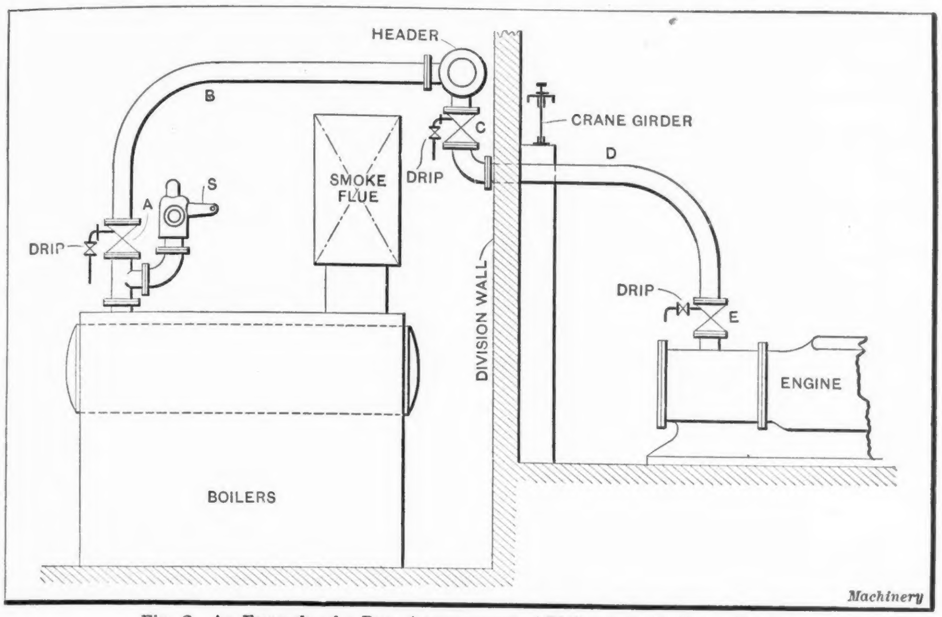


Fig. 6. An Example of a Poor Arrangement of Piping from Boiler to Engine

A poor arrangement of steam piping between the boilers and engines in a certain plant is shown in Fig. 6. In this case, *A* is a gate valve placed directly above the steam outlet and safety valve connection of the boiler. A pipe bend *B* rises from the gate valve and makes connection with the side of the main steam header. As will be noted, the steam connection to the engine is taken from the bottom of the main steam header through gate valve *C*, bend *D* and throttle valve *E*. The piping system was so arranged in order to carry the bend *D* underneath the crane girder in the engine room, as shown. This piping system is very poorly arranged, although it would not appear so at first glance. For instance, when gate valve *A* on any of the boilers is closed, bend *B* will gradually fill up with water, due to condensation in that branch of the system, and to water passing over to it through the main header. When valve *A* is opened again to put the boiler into service, the water in bend *B* will be driven over to the main header and from there to the engine cylinders, causing water-hammer and possibly damage to the piping system and the engines. High-speed steam engines are usually provided with but a very small clearance space in the cylinders at each end of the piston. If this clearance space between the piston and the end of the cylinder were to be filled with water while the piston was traveling at a high rate of speed, the water, being practically incompressible, would cause the full force of the piston to be transferred almost instantly to the cylinder cover, which would probably cause rupture.

If the engine is cut out of service by closing valve *E*, leaving valve *C* open, the bend *D* will fill up with water and drain into the engine cylinder when valve *E* is opened again. If both valves *E* and *C* are closed when shutting down the engine, water will still collect in the header above valve *C*, and unless properly drained off will return to the engine again when the valves are opened to put this unit in operation. Wherever a valve forms a water pocket in a steam line, as shown by valves *A*, *C* and *E*, the valves should be drained from above the seat. The system illustrated in Fig. 6 was arranged with drip connections placed above each valve seat, but experience in this plant shows that the water of condensation was not always drained off before starting up the plant in the morning, and quite frequently the piping system was subjected to heavy shocks from water-hammer; the engines have also been stalled by slugs of water coming over with the steam flow and lodging in the engine cylinders.

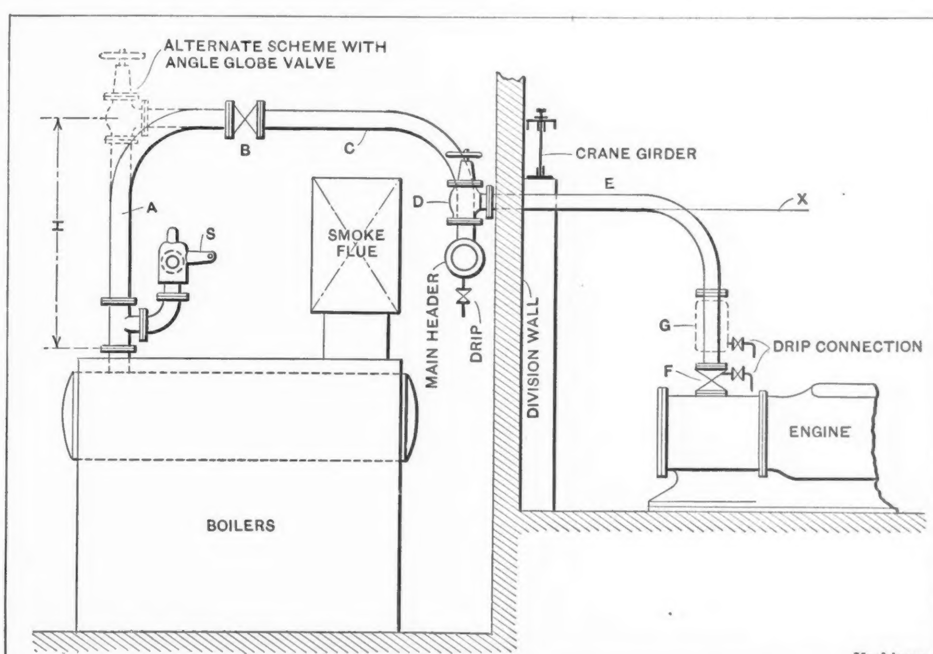


Fig. 7. Improved Arrangement of Piping for the Same Installation as shown in Fig. 6

* Address: 987 Summit Ave., Bronx, New York City.

Fig. 7 shows a much better arrangement of the piping system, in which the same number of valves is used as in the previous case. Boiler stop valve *B* is placed at the highest point of the piping system and does not form a water pocket in the line when closed, as any condensation occurring in bend *A* will drain back to the boiler, and condensation occurring in bend *C* will drain into the header by gravity as fast as it forms. The same result would be obtained by placing an angle valve above the boiler, as shown in dotted lines; this angle valve would take the place of the straight-way valve *B*. This valve should preferably be what is known as an automatic stop and check valve, for reasons to be stated later. An objection to placing the boiler valves as shown in Fig. 7 is that where valves are placed so high above the boiler nozzle, there is a tendency toward vibration of the piping system, unless they are properly supported or anchored. It will be noted that the valve is at a distance above the point of support as indicated by *H*. In this case, the steam for the engine is taken from the top of the main header through angle valve *D*, bend *E* and throttle valve *F*. When the angle valve *D* is closed, only a very small quantity of water will collect above in this line, as mentioned later in connection with the discussion of automatic stop and check valves.

In each of the cases just described, it was necessary to provide for a safety valve connection in the piping system, as shown at *S* in Figs. 6 and 7. This arrangement was necessary as no separate connection was provided for a safety valve on the boilers, and in all cases a safety valve should be provided for each boiler. It will be noted that the boiler stop valve is placed above the safety valve connection. In no case should a valve of any kind be placed between the safety valve and the boiler, for if such a valve was to be closed at any time while pressure was on the boiler, it would prevent the safety valve from acting, and any excess pressure in the boiler might cause a disastrous explosion, killing or maiming the attendants and causing the plant to be shut down until repairs could be made.

Automatic Stop and Check Valves

Modern practice in steam power plant design calls for two valves in each steam lead from the boilers—the steam pipe which connects the boiler with the main header. One of these valves should be placed at the steam outlet of the

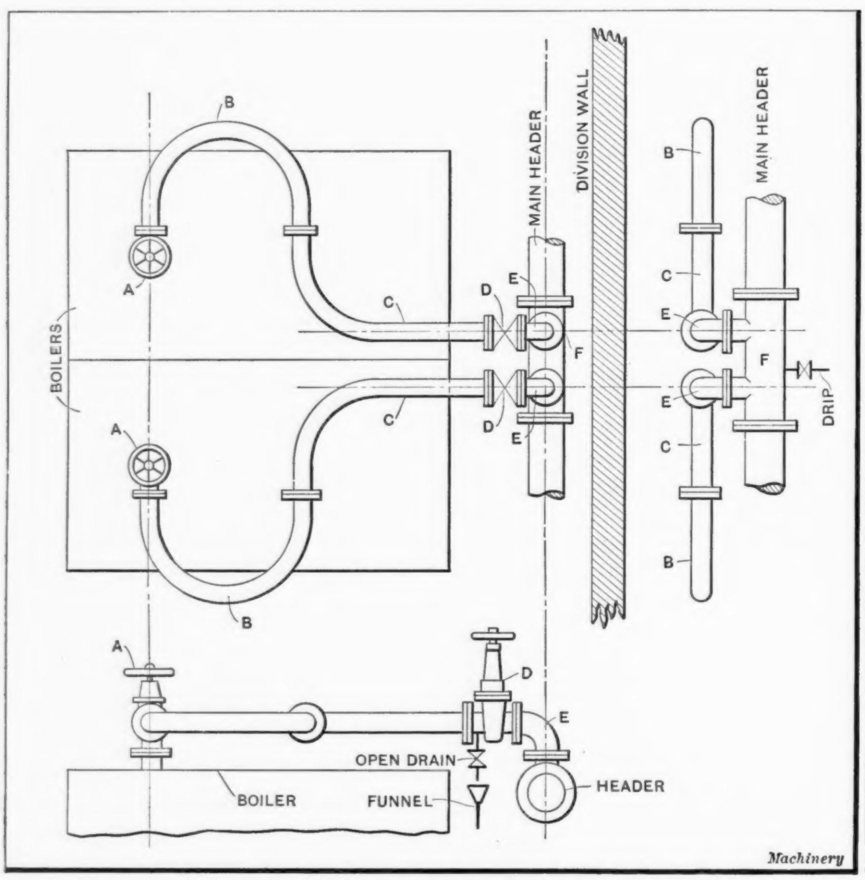


Fig. 8. Arrangement of Piping between Boilers and Main Header possessing Considerable Flexibility

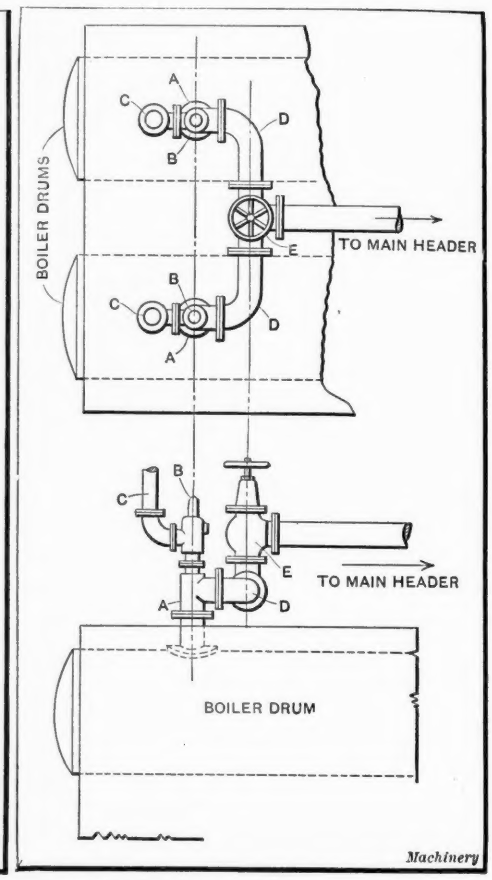


Fig. 9. Cross-over Connection between the Steam Drums of a Large Water-tube Boiler

valve *F* from the condensation of a small volume of steam remaining in bend *E*. If the angle valve *D* is not absolutely steam-tight, however, any leakage of steam through the valve will condense in bend *E* and gradually fill the pipe with water. Modern practice calls for a steam separator to be placed above or close to the engine throttle valve as shown at *G*. This separator does not add greatly to the cost of the piping system and is a protection to the engine cylinder, besides insuring drier steam and more economical operation. With the separator placed as shown in Fig. 7, if the throttle valve *F* is closed and angle valve *D* left open, the water of condensation forming in pipe *E* will drain into the separator as fast as it collects. Without the separator, the water of condensation would form in pipe *E* up to the point *X*, unless the valve *D* were closed and in a steam-tight condition. Experience shows that where two valves are placed as shown at *D* and *F*, the valve *F* is closed in, shutting down the engine, and quite frequently the operator neglects to close valve *D*. As will be noted in Figs. 6 and 7, only one valve is placed in the piping between the boiler and the main header. It is advisable to have two valves boiler and the other at the main header, as shown in Fig. 8. The valve placed next to the boiler nozzle should be what is known as an "automatic stop and check valve," so called because it closes automatically when the pressure in the boiler falls below the pressure in the steam main, and opens automatically when the pressure in the boiler exceeds the pressure in the steam main. Automatic stop and check valves are coming into more general use every day, and where two or more boilers feed into a common main or header, they are required by law in some countries. If several boilers feed into the same main and are not properly protected by these automatic stop valves, it is evident, that if a tube blows out in any one boiler, the steam from the other boilers will discharge through the main into the damaged boiler and out through the ruptured tube. This sudden rush of steam to the disabled boiler will cause a rapid drop of pressure in the other boilers, and as the pressure decreases in the boilers a large quantity of water will be rapidly converted into steam at the lower pressure, thus causing violent water-hammer; in extreme cases, the result of this condition may even cause an explosion in one

or more of the sound boilers. A sudden drop in pressure in a boiler causes water to be lifted over with the steam, and this water flowing to the engines may result in an engine wreck. If a tube should blow out in a boiler that is properly protected by an automatic stop and check valve, the automatic valve will close when the pressure in the boiler falls below that in the main. In this case, as soon as the damaged boiler empties through the ruptured tube, the attendants can return again to their stations and continue the operation of the plant, thus avoiding a shut-down while making repairs. Automatic stop and check valves can now be purchased in all the standard sizes, and as they cost but little more than the regular hand-operated stop valves, they should be given the preference, regardless of the slight difference in cost. Boiler explosions have been caused by opening the boiler stop valve by hand to put the boiler into service before the pressure in the boiler was the same as the pressure in the main. When the valve was opened, the steam from the main rushed into the boiler, causing water-hammer which resulted in an explosion. This could have been avoided by equipping the boilers with automatic stop and check valves, in which case the valve would open automatically when the pressure in the boiler slightly exceeded that in the steam main, or boiler header, as the case might be.

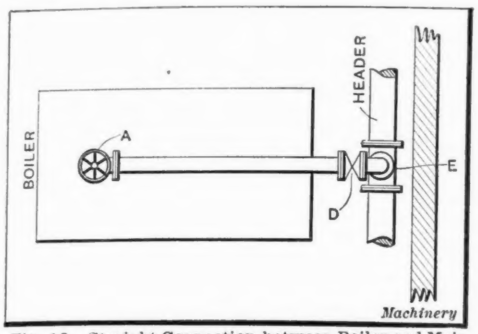


Fig. 10. Straight Connection between Boiler and Main Header with Practically no Flexibility

Steam Connections between Boilers and Main Header

When making connections between the boilers and the main steam header, proper provision should be made for taking up or relieving expansion and contraction strains. The piping should, if possible, be free from water pockets of any kind, and where such pockets are unavoidable, they should be automatically dripped free from water at all times during operation and before starting operation. The entire piping system, and particularly the valves, should be located and arranged to provide for convenient operation. A method quite frequently employed in connecting a battery of boilers to the main steam header is shown in Fig. 8. Automatic stop and check valves are placed at the outlet of each boiler, as shown at *A*. The U-bends *B* and the square bends *C* provide for expansion and contraction and for any slight movement of the main header. These bends, if properly proportioned, are quite flexible and will give sufficiently to relieve the strain at the joints. From the gate valves *D* the piping makes connection with the top of the header through the elbows *E* and the manifold tee *F*. If so desired, the elbows *E* may be replaced by angle valves, in which case the gate valves *D* will not be required. The automatic stop valves *A* may be closed by hand when required, and the gate valves *D* used as stop valves only in cases of emergency when the automatic stop valves get out of order, or when it is necessary to pack joints, or renew gaskets in the piping between the boiler and main header.

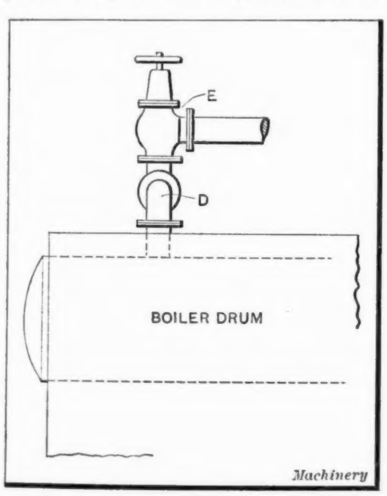


Fig. 11. Simplified Form of Cross-over Connection where Separate Connections for Safety Valves are used

If the gate valves *D* were omitted, there would be no means of shutting down a boiler for cleaning or repairs, in case the automatic stop valves were out of order, without shutting down a section of the main header to do so. The system shown in Fig. 8 contains no water pockets or low spots in which water could collect, except the header, and this should be dripped at frequent intervals. If either valve *A* or *D* should leak under pressure when both valves are closed, however, the steam leaking past the valve seat will condense in the bends *B* and *C*, and in time this section of the piping will fill up with water. This water will be driven back to the header when the valves are opened again and cause trouble. For this reason it is advisable to pitch the piping slightly from valve *A* to valve *D*, so that any water that condenses will drain in that direction and provide an open "test drain" connection at the inlet side of valve *D*. This drain may be arranged to discharge into a funnel and it can then be piped to some convenient source of waste. In this case if both valves *A* and *D* were closed when shutting down the boiler, the drain could be opened before putting the boiler on the line again so that any water in bends *B* and *C* would be drained off. This open drain connection will also be found useful, when testing the valves for leakage, by simply closing both valves *A* and *D* while under pressure and opening the drain valve. If the valves leak, steam will continue to escape through the drain. The manifold tee *F* takes the place of two single tees and saves one pipe joint in the main header for each battery of boilers. Manifold tees are special fittings that are seldom kept in stock, and for this reason they cannot be obtained as quickly as standard stock fittings. Although special, however, they should not be much more expensive than the equivalent number of standard tees required for the same purpose. The manifold tee shown at *F* has four flanges to be faced and drilled, whereas two standard tees to answer the same purpose would have three flanges each to be faced and drilled; this means a saving in machine work on two flanges which should, to a large extent, offset the additional cost of the special casting, pattern work, molding, etc.

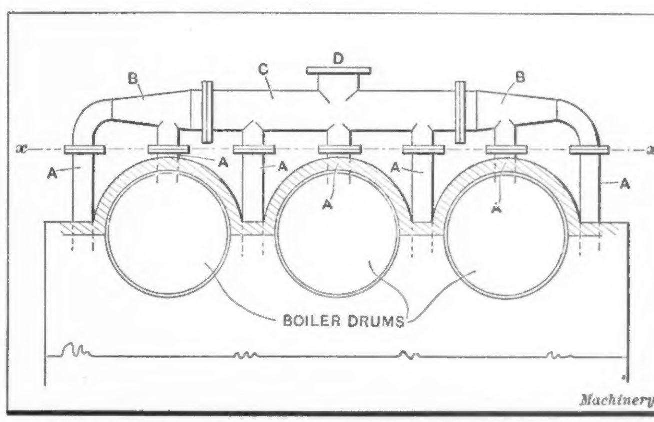


Fig. 12. Cross-over Connection between Superheater Outlets of a 650 H. P. Three-drum Water-tube Boiler

Fig. 10 shows a straight connection between the boiler and main header. This is a very rigid arrangement, as no provision is made for expansion and contraction, vibration, etc. It is quite evident that any movement of the main header in either direction will cause a twisting movement on the joints at the automatic check valve *A*, the gate valve *D* and the elbow *E*, and in a short time, this will grind away the material in the gaskets and cause the joint to leak at the flanges. Piping connected in this manner is a constant source of worry to the engineers in charge of the station, as they find it difficult to keep the joints steam-tight. In all cases flexible pipe connections should be provided between the boilers and the main header, as well as between the engines and main steam header.

Cross-over Connections between Boiler Drums

Large water-tube boilers are quite frequently built with two or more steam drums to a boiler, in which case it is customary to provide a cross-over connection between each boiler drum, and lead off to the main steam header through one automatic stop and check valve and one branch pipe, rather than to connect each steam drum of the boiler independently to the main steam header. Fig. 9 shows an example of a cross-over connection for a two-drum boiler. A flanged tee is placed next to the steam outlet of each boiler drum at *A*. An outlet at the

top of each tee is provided for the safety valves *B*. These safety valves discharge through pipes *C*, which should project at least six or eight feet above the top of the boiler setting to prevent scalding the attendant, should he be standing on the boiler at the time the safety valve opens due to excess pressure in the boiler. In some cases, the discharge pipes *C* are carried above the roof line, but in such a case the boiler attendant would not be able to tell which safety valve was discharging unless he climbed up on top of the boilers or went up on the roof to see from which pipe the steam was escaping. In the writer's opinion it is best to have the safety valves discharge into the boiler room below the roof line, as this makes it possible for the attendants to tell at a glance which valve or valves are discharging. In case any of the safety valves leak, a steady jet of steam may be seen issuing from the end of the pipe, and the attendants will know that the valve is in need of repairs. The elbows *D* provide a common connection between each boiler drum and the automatic stop and check valve *E*, from which a pipe connection is made to the main steam header. In case a separate safety valve is connected on each boiler drum, in addition to the main steam outlet, the cross-over connection may be simplified by arranging the piping as shown in elevation in Fig. 11. In this case, the two tees *A* of Fig. 9 are not required and the elbows *D* make connection direct with the steam outlet of each boiler drum. The valve *E* is of the automatic stop and check type. Boiler cross-over fittings should be cast of steel, in preference to iron, especially for high-pressure service and where superheated steam is used.

A cross-over connection between the superheater outlets of a large three-drum water-tube boiler is shown in Fig. 12. The steam, when it leaves the boiler drums, passes down through the superheaters (not shown) and out through the superheater pipes *A*, from which it passes to the cross-over manifold fittings *B* and *C*. The automatic stop and check valve is placed next to the main steam outlet at *D*. The superheaters and the pipes *A* are provided by the boiler manufacturers up to the point *x*–*x*, and the piping contractor provides the piping beyond this point. The cross-over manifold is made in three pieces and should be of cast steel in preference to cast iron.

In some cases it is desirable to operate the main engine units on superheated steam, and the auxiliary engine units on saturated steam. Under such conditions, the reader will readily understand that two separate connections will be required at each boiler drum and that separate branches and headers will be necessary to convey the steam to the different units, that is, two separate and distinct steam piping systems, one for the superheated steam and one for the saturated steam.

* * *

HOW TO CURE A DUSTY CONCRETE FLOOR

The Aberthaw Construction Co. of Boston, contracting engineers specializing in concrete, recommend the following method of curing a dusty concrete floor: Get the surface entirely dry, then paint it with a mixture of boiled linseed oil thinned with gasoline. Give it several coats, until the oil shows glossy on the top. The theory of this is that the linseed oil, having been boiled, has lost most of its volatile components and is practically permanent. The gasoline thins this down enough so that it will strike into the pores. A little experimenting will show the proper proportions. The thinner it is, the more coats will be required and the deeper it will strike in. The floor that is causing serious trouble from dust can often be cured with very little trouble and expense in this way.

* * *

The Pennsylvania R. R. is vigorously prosecuting its campaign for greater safety and has lately distributed 50,000 copies of a book of "don'ts" for employes working on trains, tracks and in the shops. These "don'ts" include prohibitions of common practices fraught with danger, such as standing between cars when coupling, stepping on footboards when locomotives are approaching, going under trains to make repairs or adjustments without proper protection, piling coal on tenders in such a manner that it may fall off, etc.

WIRE BENDING IN THE FOOT-PRESS

It is not often that the ordinary foot-press can be fitted with tools for bending, or working wire, and still compete with the four-way automatic wire bender, but there are exceptions. The first illustration, Fig. 1, shows both the press and tools, and Fig. 2, the successive operations necessary to form the spring. The springs, which are used on the ordinary spring clothes-pin (shown at the bottom of Fig. 2), were wanted in comparatively small lots (two or three hundred thousand of a kind), and the first cost of the tools was an important matter.

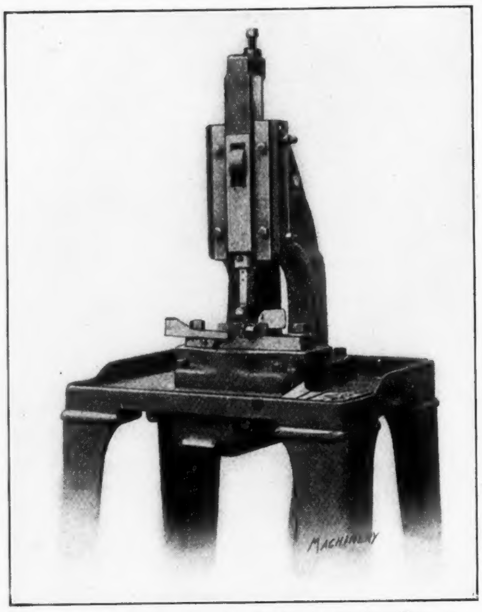


Fig. 1. Foot-press fitted with Tools for bending a Clothes-pin Spring

Fig. 1 shows the press, which is of the ordinary "kick" type, fitted with a punch, which, taking the wire direct from the straightener, cuts it off to the proper length, and then in the three successive operations shown, bends it to the required shape. The spring, which is made of 0.0625 inch piano wire, is, as any one who has had

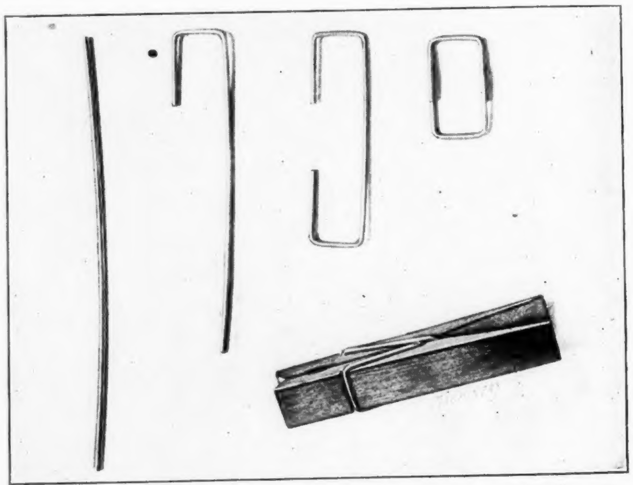


Fig. 2. Successive Operations of Bending the Spring, and Clothes-pin for which the Spring is made

experience in working wire well knows, very hard to "set" to make it hold its shape properly, and this was the reason for choosing the foot-press rather than a bench bender.

The first operation is cutting off the wire. The second and third, bending, these being made without any change in the tools. The fourth is effected by the addition of a guide to the punch only. A boy or girl will turn off about 5000 finished springs per day, which, considering the low cost of the tools, makes the machine a profitable investment. The tools were made for the Carolina Washboard Co. of Raleigh, N. C., by J. L. Lucas & Son, of Bridgeport, Conn.

* * *

The Society of Motor Manufacturers in Great Britain has offered a prize of $10,000 for a fuel for automobile engines which is produced entirely from materials available in Great Britain and which is marketable at a competitive commercial price. It is also stipulated that the fuel must prove satisfactory for present designs of engines, and must be obtainable in sufficient quantities to guarantee an unlimited and continuous supply.

AUTOMATIC SCREW MACHINE EQUIPMENT—2

TOOL EQUIPMENT USED ON NATIONAL-ACME MULTIPLE-SPINDLE AUTOMATIC SCREW MACHINES

BY DOUGLAS T. HAMILTON*

In the previous installment of this article, a collection of the tools used on the National-Acme automatic screw machines for internal cutting and threading were described; in the following, attention will be given to a description of box-tools, shaving tools, knurling and thread rolling tools.

Box-tools

The type of box-tool commonly used on the "Acme" automatic is that known as the over-cut type; this usually carries two cutting tools as shown in Fig. 15. The front cutting tool, when in operation on the work, is set "tangentially" to the work, while the rear cutter is worked radially in relation to the center of the work. The front tool, when used for taking

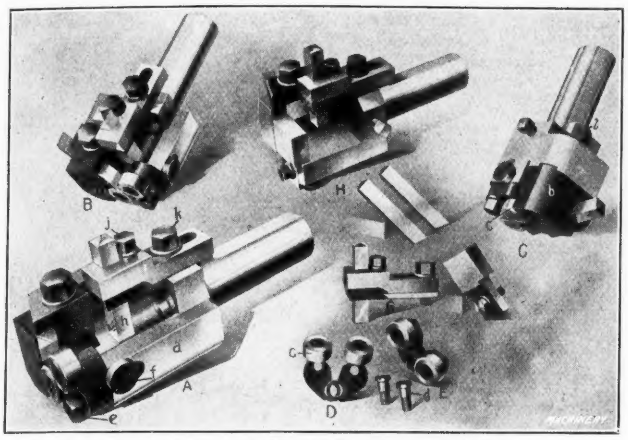


Fig. 15. Group of Over-cut Box-tools used on the "Acme" Multiple-spindle Automatic Screw Machines

a finishing cut, is set about 0.010 inch in advance of the supports and is ground a little high at the rear to provide for clearance.

Three views of the over-cut type of box-tool appear at *A*, *B* and *C*, in Fig. 15. The body *a* is a machine-steel forging, turned down at the rear end to form a shank, and milled out at the front for the reception of the tool-block *b*. This block is provided with a tongue fitting in a groove in the body of the box-tool, and is held tightly up against the box-tool body by a bolt *l*. The hole in the body through which the bolt *l* passes is elongated to provide for adjustment of the tool-holder. The roller supports *c* which are shown dismantled at *D* and fastened to the holders at *E*, are made of hardened and ground tool steel; they are held to the holders by shoulder-screws *d*, being free to rotate on the latter. The support holders are held to the box-tool body by a cap-screw *e* and are backed up by large headed screws *f*. Screws *f* are adjustable and the under sides of their heads are raised by

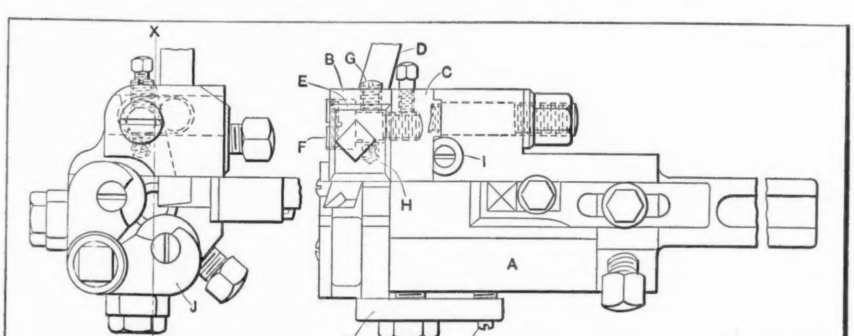


Fig. 16. Spring-releasing Type of Box-tool

headless screws located in the body of the box-tool to form a "heel." The rear cutting tool *h* is held in a tool-holder *i* by a wedge (not shown) and a cap-screw *j*. The tool-holder *i* is retained in a V-groove in the body of the box-tool by a cap-screw *k* and is provided with an elongated slot for adjustment. The shank of the tool-holder is provided with a hole and bushing in which a centering tool or other internal cutting tool can be retained.

The box-tool shown at *H* in Fig. 15 is known as a "round

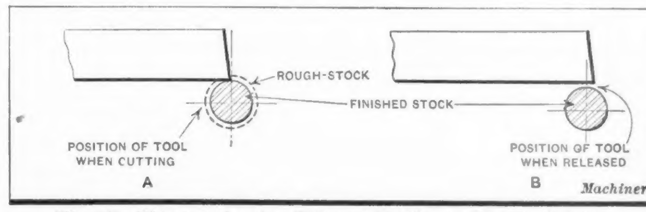


Fig. 17. Diagram showing Different Positions of Box-tool Cutter held in Tool shown in Fig. 16

box-tool" because of the rounded shape of its body. It is provided with a solid support, which is very rarely used except on small brass work. It is particularly suited for use in the "first" position when the forming cut overlaps the box-tool cut. The support is held in position by a screw and is backed up by an additional screw. This type of box-tool is also provided with roller supports for general work.

Spring-releasing Box-tool

The regular box-tool, when used for taking heavy roughing cuts, usually leaves a spiral mark on the work in backing off. This is due to the extreme point of the cutting tool becoming heated, and a certain amount of the cuttings welding to it thus forming a ragged edge, which produces an objectionable mark on the work when the tool is withdrawn. To overcome

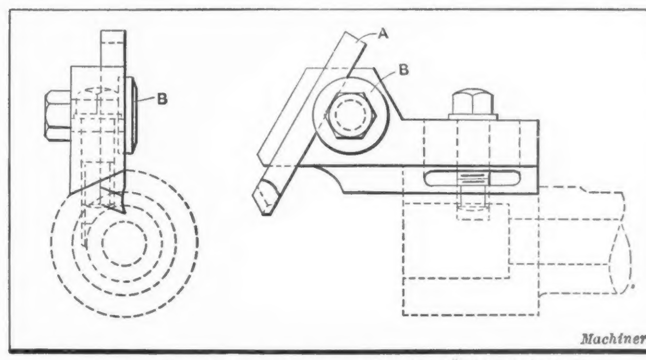


Fig. 18. Chamfering Attachment for Standard Drill-holders

this difficulty, the National-Acme Mfg. Co. has designed for use on its screw machines the "spring-releasing box-tool" illustrated in Fig. 16. In this design, the front cutting tool is removed from the work on the back stroke, and is thus prevented from producing an objectionable mark. The body of the box-tool is practically identical in construction with those shown in Fig. 15, with the exception, of course, that the front part holding the turning tool is designed especially to provide for the spring-releasing feature. The front part of the body *A* is cut out as shown, and a block *C* is held to it by a bolt and nut. This block is provided with a tongue so that it is adjustable in a vertical direction on the face of the box-tool body. The tool-holder proper *B*, is provided with an angular groove which fits over a corresponding tongue on the face of the block *C*. The tool-holder is held to block *C* by a shouldered screw *E*, the diameter of which is smaller than the elongated hole in the tool-holder, to provide for a slight movement. Screw *E* is backed up by headless screw *F* to prevent it from loosening when the tool-holder is moved back and forth on it.

The spring-releasing device is simple in construction. In the tool-holder *B* is held a spiral spring *H* which acts on a plunger, the latter bearing against the body of the shouldered screw *E*. The action of this spring draws the tool-holder forward toward the center line of the box-tool body,

*Associate Editor of MACHINERY.

its movement being stopped by the headless screw G. Now as the tool-holder B works on a tongue which is at an angle to the horizontal line X–Y of the box-tool, it follows that the spring H will always keep the tool up at its highest point, as illustrated at B in Fig. 17. When the front cutting edge of the tool strikes the work, it compresses the coil spring H, forcing the tool and holder back until its movement is stopped by the shouldered screw E. This position is illustrated diagrammatically at A in Fig. 17. Then when the main tool-slide stops advancing and begins to retreat, the pressure on the cutting tool is released, allowing the spring to force the tool-holder up on the inclined "angle" (or tongue) and thus raise the tool from the work as illustrated at B in Fig. 17. The block C carrying the tool-holder is adjusted vertically

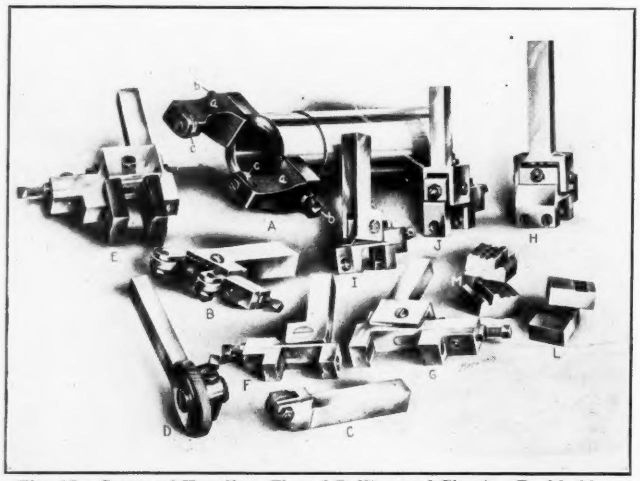


Fig. 19. Group of Knurling, Thread Rolling and Shaving Tool-holders

for turning different diameters by means of the collar-head screw I.

The manner in which the roller supports are held in this box-tool also differs to a slight extent from the method used in the box-tools shown in Fig. 15. In this case, the roller supports are held in holders J which are backed up by blocks K; these blocks are held in place by a cap-screw M and drilled out to receive a headless screw L, the latter forming a heel on which the rear part of the block rests. As the diameter of the work increases, the screw M is released, allowing the roller support holders J to drop back to bring the rolls to the proper position. Then the screw L is brought out until the block K is practically in a parallel position, when the screw M is tightened.

An attachment for a regular drill-holder which carries a cutting tool for chamfering or facing is shown in Fig. 18. This is held to the body of the drill-holder, and is provided with a groove for the cutting tool A which is held in place by a clamp bolt B and a nut. The attachment is adjustable

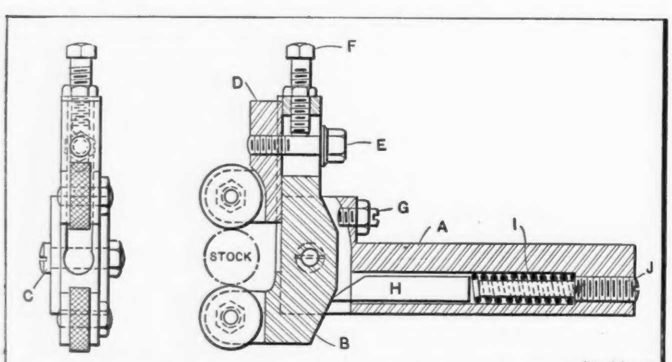


Fig. 20. Double Knurl-holder of the Adjustable Type for Use on the Top- or Side-working Tool-slides

along the body of the holder so that the cutting tool can be brought to the desired position.

Knurling and Thread Rolling Tools

A group of knurling and thread rolling tool-holders is shown in Fig. 19. The knurl-holder shown at A is used in the end-working tool-holders, being provided with a cylindrical shank for this purpose. The knurl-holders proper, a, are made in the form of slides, tongued in the shank, and are held to the latter by a cap-screw in the same manner as the shaving tool shown in Fig. 24. The knurl-holders are located by set-screws b. The knurls c which are cut right- and left-hand, respectively, are held in slots in the holders by a screw, and are used for producing a diamond knurl on the work.

A double adjustable knurl-holder is shown at B in Fig. 19, and in detail in Fig. 20, to which reference should now be

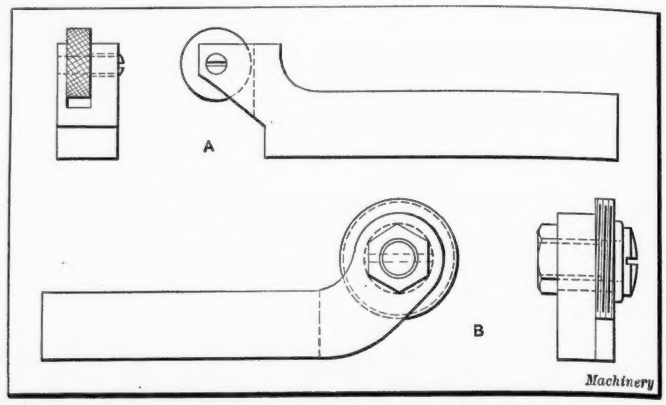


Fig. 21. Single Knurl holder and Thread Roll-holder

made. This holder is usually held on the top-working tool-slide and is used for producing a diamond knurl on the work, two knurls of different hands being employed. The shank A of this holder, which is retained in the slot in the top-working tool-slide, is slotted on the front end to receive swinging member B, which is pivoted on a screw C. The lower knurl is retained in the holder B on a threading stud provided with a nut, and the top knurl is held in an adjustable holder D in the same manner. Holder D is provided with a tongue fitting in a corresponding groove in the part B and it is held to the latter by a cap-screw E, which works in an elongated hole in B and is stopped by the screw F. The movement of

Fig. 22. "Acme" Self-opening Die Head used as a Knurl-holder

the member B is controlled by the stop-screw G, against which the holder is held by a bevel pin H and a coil spring I. Pin H is stopped by a headless screw J. The spring and stop arrangement in this holder gives it a certain amount of flexibility, thus making it unnecessary to set the holder accurately, as it is possible for it to accommodate itself easily to the work.

A holder for retaining a single knurl is shown at C in Fig. 19 and also at A in Fig. 21. This holder generally carries a knurl for producing diamond knurling, but, of course, can be used for holding a spiral knurl, with equally good or better results. It is held on the top- or side-working tool-slide, but generally on the former, and is usually applied radially to the work. That is, it does not pass either under or over the work, but is forced directly up against it.

Two types of thread roll-holders commonly used, are shown at D in Fig. 19 and at B in Fig. 21. The holder shown in the

latter illustration is of simple design, and when in use is presented radially to the work and slightly off center so as to permit the tool springing away a certain amount to follow the arc of the stock. This makes it unnecessary to set the tool absolutely correct in regard to position for depth of thread. Of course the tool should not be set so that it will spring much—just enough to relieve the strain which would be imposed on the tool if it were presented at "dead centers." The roll in the holder shown at D in Fig. 19 is held on a shouldered stud, which is retained in the holder by a nut and is prevented from turning by the set-screw shown. This thread roll-holder is shown applied to the work in Fig. 25.

A knurling tool-holder which is held in the end-working tool-spindle and carries four knurls is shown in Fig. 22. This

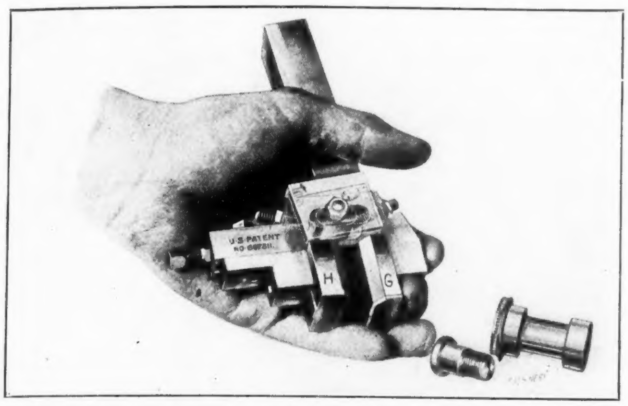


Fig. 23. Patented Shaving Tool used on the "Acme" Multiple-spindle Automatic Screw Machine, and Some of the Work on which it was used

is a regular "Acme" self-opening die-holder in which four knurls are held by studs, the latter being threaded into the chasers and separated from them by washers as shown. Two of the knurls are cut right-hand and the others with left-hand spirals. Applying four knurls to the work in this manner divides the work between the knurls, and facilitates the production of deeper knurling in less time than would be possible with a single knurl. Two spiral knurls of different hand, of course, produce a diamond knurl on the work.

Calculating Diameter of Thread Roll

Thread rolling is used in producing a thread behind a shoulder where it would be impossible to cut it with a die, and thus the necessity of a second operation on the work is

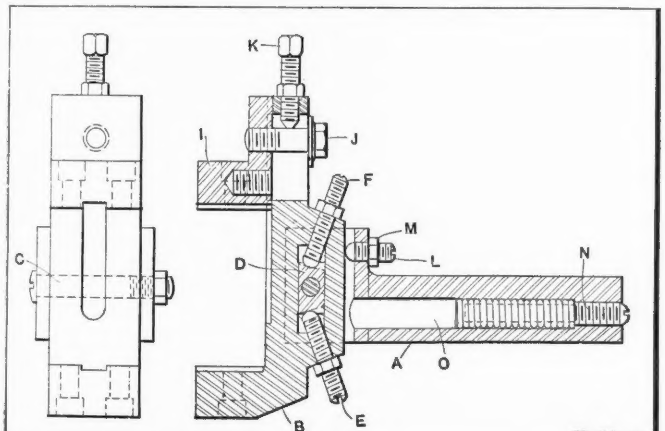


Fig. 24. Construction of Patented Shaving Tool-holder

dispensed with. A thread roll is generally used on brass and similar materials, owing to the difficulty of securing a brand of steel which will stand up on harder materials. The National-Acme Mfg. Co. is now experimenting with different kinds of steel from which to make thread rolls for steel work, and has found that a chrome-nickel steel containing from 15 to 20 points carbon* gives fairly good results on this work. The roll is made anywhere from $1\frac{1}{4}$ to $2\frac{1}{4}$ inches in diameter and sometimes larger—depending on requirements—and is provided with a multiple thread when the work is smaller than the largest diameter of the thread roll. The formula used in determining the diameter of the thread roll* is as follows:

$$D = N\left(d_1 - \frac{d_2}{0.625}\right)$$

in which

D = outside diameter of thread roll;

N = number of "starts" or approximate ratio between the diameter of the thread roll and work;

d_1 = outside diameter of piece to be threaded—(diameter after completion of thread);

d_2 = double depth of thread.

For example, assume that it is necessary to roll a thread $\frac{1}{4}$ inch in diameter by 24 pitch. Then as the roll must not be less than $1\frac{1}{4}$ inch in diameter, our ratio will be 8. Suppose that the piece has a sharp V-thread, then:

$$D = N\left(d_1 - \frac{d_2}{0.625}\right)$$

$$D = 8\left(0.250 - \frac{0.07261}{0.625}\right)$$

$$D = 8\ (0.250 - 0.0451) = 1.6392 \text{ inch.}$$

The thread on the roll should be made with a sharp vee top and bottom, whether it be used for a sharp vee or a U. S. standard thread. A thread roll for producing a thread on brass and similar materials should be made from 3 per cent nickel steel containing about 12 points carbon. The heat-treatment recommended is as follows: Carbonize six hours in straight coarse bone (not bone dust), heating to a temperature of 1600 degrees F., and then let cool off in pots

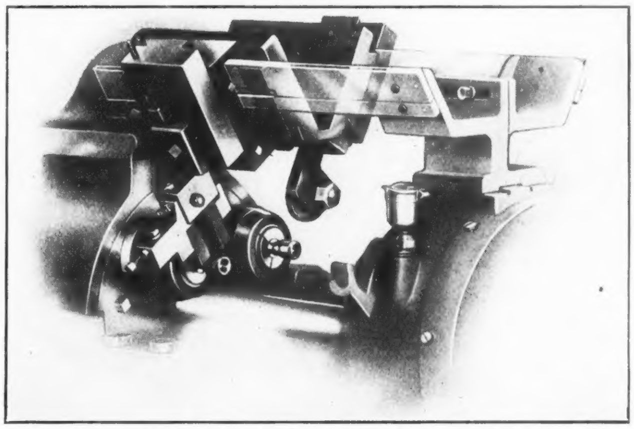


Fig. 25. Illustration showing how a Shaving Tool and Thread Roll are applied to the Work

without removing the work. Then heat to 1550 degrees F. and quench in oil. Reheat to 1350 degrees F. and quench in water, after which draw the temper to 400 degrees F. in oil.

Shaving Tool-holders

The shaving tool employed for finishing work on the "Acme" automatic is a patented device and is illustrated at E, F, G, H, I and J in Fig. 19, and also in Fig. 23. The holder shown at E is supplied with a blade and support, while those shown at F and I are of light pattern, those at G and J regular pattern and that at H of the heavy type. Plain and irregular form supports and shaving blades are shown at L and M, respectively. The general construction of these shaving tool holders is clearly shown in Fig. 24. The holder proper, A, which is generally held in the top-working tool-slide (see Fig. 25, where a shaving tool is being used to prepare the portion of the work on which a thread is to be rolled) is milled out to receive the L-shaped holder B. This is pivoted in the holder by a bolt C, on the body of which is held an oblong swivel block D, the latter fitting in an elongated slot in the holder B. As will be noticed, the block

* For additional information regarding the composition of chrome-nickel steel, see the Data Sheet Supplement accompanying the June, 1912, number of MACHINERY, engineering edition.

* [The formula here given is that used by the National-Acme Mfg. Co. in making thread rolls for brass and other soft materials. The calculations in this formula are based on the diameter of the work after the completion of the thread, instead of the diameter of the blank (which is approximately equal to the pitch diameter), as was the case in the formula which appeared in the August, 1912, number of MACHINERY. For further information on this subject, reference should be made to the article just mentioned.—EDITOR.]

D is considerably shorter than the hole in which it slides, thus allowing for adjustment of the holder *B*. This is effected by screws *E* and *F*, provided with lock-nuts and fitting in slots in the block, the faces of which are at right angles to the axis of the screws. The support *G*, Fig. 23, which has the same contour on its top face as the blade *H*, is provided with a tongue and held to the holder *B* by one or two screws (see Fig. 27), depending on the pattern. The shaving blade *H* is held to the holder *I* in the same manner, the latter being adjustably mounted on the holder *B* by a cap-screw *J*. Holder *I* is adjusted to set the support and shaving tool the required distance apart by a screw *K* which comes

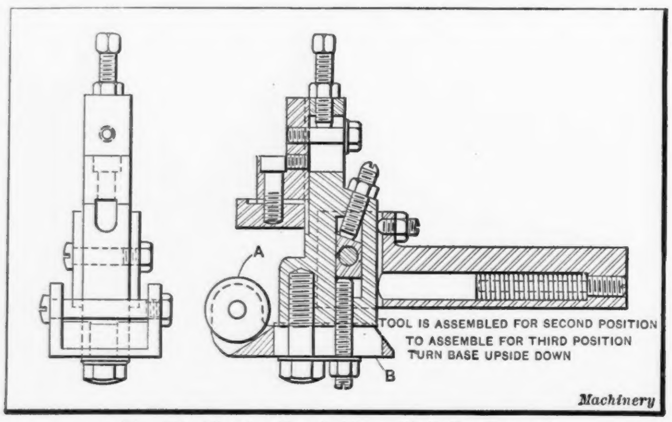


Fig. 26. Shaving Tool-holder with Roller Support

in contact with the body of the screw *J* and is provided with a lock-nut.

In operation, the holder *B* is set in the desired position by adjusting screws *E* and *F* until the support, when in operation on the work, will assume the position shown in Fig. 27, that is, the top face of the support should be parallel with the top of the tool-slide. The screw *L* and the lock-nut *M* (see Fig. 24), are then adjusted to allow the holder *B* to swing up, raising the support by means of the spring plunger *O*, this being stopped by the set-screw *N*. This action makes the support bind slightly in passing over the work, bringing the cutting edge of the blade in contact with the work as lightly as possible.

Now as the support is always slightly longer than the shaving tool, and is set higher on the front end, it comes in contact with the work first, drawing down the shaving blade until the check-nuts prevent further movement of the holder.

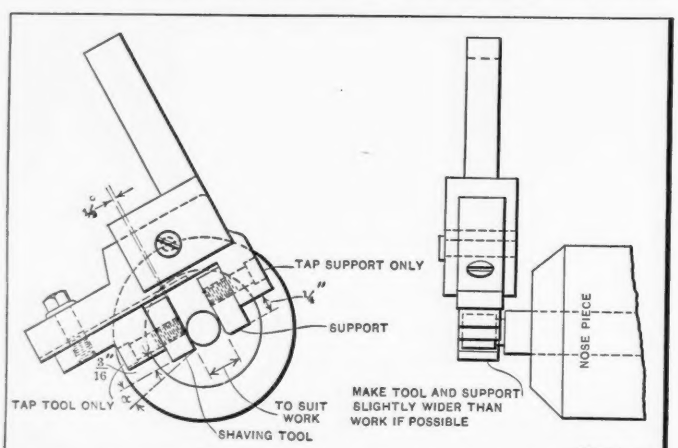


Fig. 27. Diagram showing how the Shaving Tool and Support are applied to the Work

The maximum swing provided for holder *B* is 15 degrees, but only a very few degrees of swing should be employed. In fact, excellent results are obtained by fixing the swinging member so that it is held almost rigidly. As shown in Fig. 27, the front edge of the support is rounded and the lower face of the shaving tool is set off at an angle of ½ degree from the "parallel line," thus providing for ample clearance and free working of the tool.

The type of shaving tools just described are all supplied with solid supports. A shaving tool equipped with a roller support is shown in Fig. 26. The general construction of this shaving tool is the same as that illustrated in Fig. 24, with the one exception that the roll support *A* is held in an arm *B*, which is retained in the swinging member of the tool by a cap-screw as shown. In operation, the cutting edge of the shaving tool should be exactly in line with the axis of the support, so that the blade will be "tangent" with the work when the axis of the work and roll are in a straight line.

Shaving Tools

Shaving tools of the types illustrated are only recommended for taking light finishing cuts and are not designed for removing a great amount of material. In fact, the less material removed, the better the finish. The amount of material that it is necessary to remove to obtain a good finish on the work depends to a large extent upon the character of the operation or tool used prior to the shaving operation. If the work is rough and full of tool marks, of course it is essential that these be removed, and to do this a much heavier shaving cut has to be taken than would be required if the work were comparatively smooth. The action of the shaving tool when on the work is not, practically speaking, a shaving action, but rather a scraping action. The amount

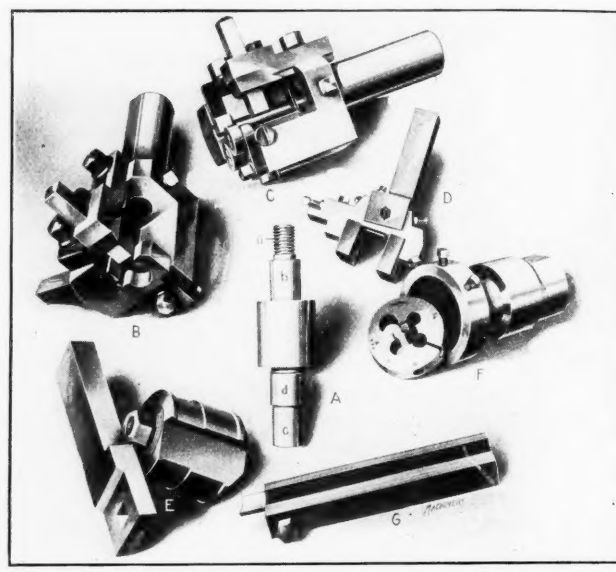


Fig. 28. Representative Group of Tools used on the "Acme" Multiple-spindle Screw Machine for producing a Shouldered Stud

to leave for shaving for various diameters of stock under general conditions is as follows:

Diameter in Inches	Amount to Remove in Inches
1/16— 1/8	0.0015
1/ 8— 1/4	0.0018
1/14— 3/8	0.0020
3/ 8— 3/4	0.0023
3/ 4—1 1/8	0.0026
1 1/ 8—1 1/2	0.0028
1 1/ 2—1 7/8	0.0030
1 7/ 8—2 1/4	0.0032

Fig. 27 shows the manner in which the shaving tool is applied to the work, and also illustrates the angles on the shaving tool for cutting various materials. For cutting steel, the front edge of the support should be practically at right angles with the lower face, while for cutting brass a negative rake should be provided, as indicated by the angle *a*. This angle varies slightly for different grades of brass, but is usually made 15 degrees. The shaving blades and supports are made from Jessop's tool steel and hardened, and are ground on the top and lower faces when of the plain type.

For cutting brass, shaving tools made from Jessop's high-speed steel have been found to give better results, as it prevents the lapping of the tool by the work. When it is necessary to make the support and shaving tool with an irregular top face, the surfaces are smoothly finished before the tool is hardened, and all the surfaces are lapped down by the work running between them. This takes only a short time to accomplish. When the support and rest are of extremely complicated shape, the support is relieved, and only bears on the wider surfaces.

In Fig. 28 is shown a representative "Acme" tooling group

for producing the shoulder stud *A*. The two box-tools *B* and *C*, one roughing and the other finishing, are used to reduce the two diameters *a* and *b*. The large body is left the same diameter as the bar, while the two diameters *d* and *c* are turned with the circular form tool *E*, which also necks the piece. The diameter *d* is finished with a shaving tool *D*. The thread is produced with a round split button die and holder *F*, and the piece is cut off from the bar by the blade-type cut-off tool *G*.

Speeds and Feeds for Internal and External Cutting Tools

This subject has been well covered in a series of articles which appeared in MACHINERY and are now in Reference Book form. Practically the same speeds and feeds used on the Brown & Sharpe automatic screw machines are applicable to the "Acme" multiple spindle screw machine, and it is safe for an operator to start with the data previously mentioned and then speed up the tools to the working speed which will give the best results on the material being worked. The Reference Books which should be referred to in connection with this article are as follows: No. 101, "Circular Form and Cut-Off Tools;" No. 102, "External Cutting Tools;" No. 103, "Internal Cutting Tools;" No. 104, "Threading Operations;" and No. 105, "Knurling Operations."

* * *

The Whitney Mfg. Co., Hartford, Conn., employs a system of storing steel used in the manufacture of Woodruff keys, transmission chain, etc., which enables a count of the tonnage on hand to be made in a few minutes at any time. Most of the steel comes in eight-foot lengths and is stored in steel racks, laid horizontally. As the steel is unloaded from the cars it is weighed in ton lots and these lots are laid in the racks with cross sticks between to separate them. Hence the number of tons in a rack is ascertained by simply counting the lots.

DRAWING A MOTOR-CYCLE MUFFLER BASE

At *I* in Fig. 1 is shown a motor-cycle muffler base made from flat sheet-metal stock in ten operations by the Acklin Stamping Co., Toledo, Ohio. The first operation is cutting the blank from the stock. It is then drawn to the proper depth in a simple push-through die, the result being shown at *A* in Fig. 1. The third operation is similar, except that the punch starts a bulge on the side of the shell, as is shown at *B*. The fourth operation is also formed in a plain push-through die using a punch so shaped that it will gather more metal where the nozzle is to be formed. The result of this operation is shown at *C*.

This die, as well as the die used for the third operation is provided with pads for ejecting the work and the punches are equipped with center knockout pins actuated by the press on the return stroke to insure the piece being pushed off from the punch. This insures the shell leaving both the die and punch.

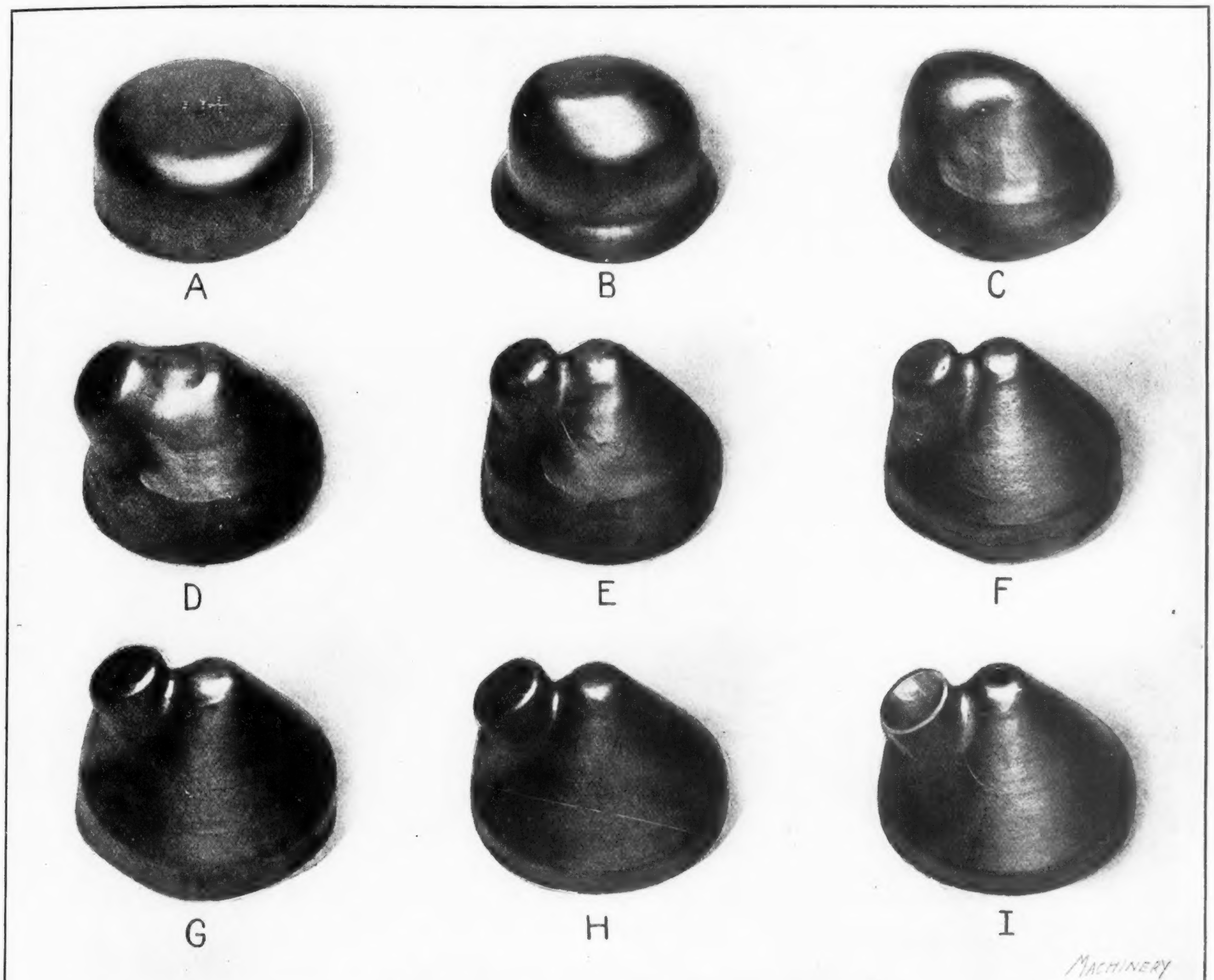


Fig. 1. Successive Drawing Operations on a Motorcycle Muffler Base

The fifth operation is performed by a round punch and die, shown in section, Fig. 2. Although the punch and die are of an ordinary type, it will be observed that the shell is placed underneath the punch in an unusual position, this being necessary in order to draw up the nozzle on the side. The result of this operation is shown at *D*.

The same principle of punch and die construction is employed for the sixth operation, and the nozzle is reduced to within one-sixteenth inch of its finished shape, as shown at *E*. The seventh operation, the result of which is shown at *F*, is accomplished by inserting the shell perpendicularly in the die, the action being to finish the cone and to size and straighten the edge of the shell. A vertical section of the punch and die is shown in Fig. 3, in which it will be seen that the die is

provided with a pocket at the right for receiving the nozzle. The punch is a plain cone without projections and is used for forming the cone and straight parts of the shell only. This punch and die, like the others, is provided with center knock-out pads.

The eighth operation resizes the nozzle and brings out the perfect lines of the cone and reduces to a minimum the radius on the corner where the nozzle joins the cone. The condition of the piece after this operation is shown at *G*. The shell is then taken to a trimming press and the surplus metal is removed while supported on trimming horns, six strokes of the press being required to make a complete revolution of the shell. The trimmed shell is shown at *H*. The operations remaining to be performed are punching the hole in the apex and the end of the nozzle. This is done in ordinary piercing dies, provided with gages suitable for the work. The

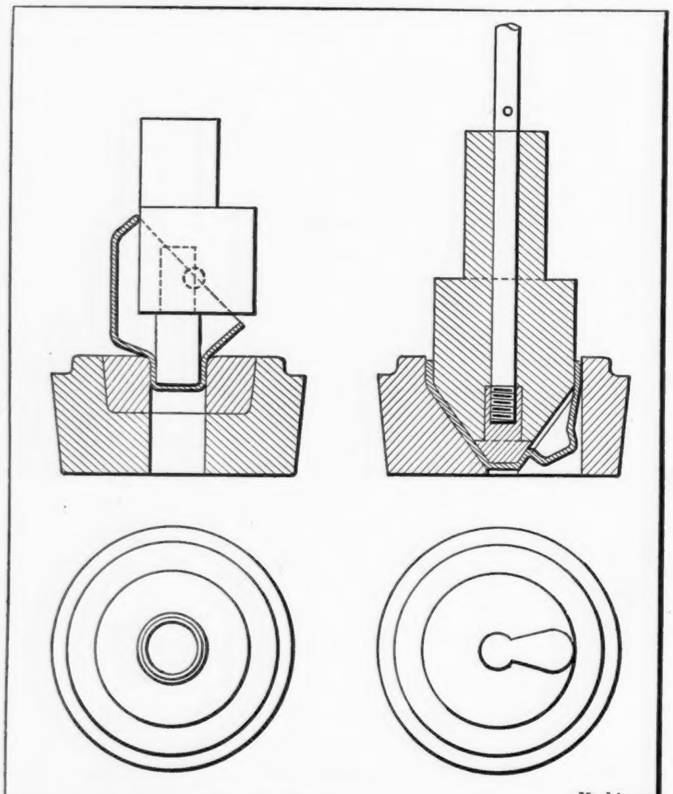


Fig. 2. Punch and Die for drawing the Nozzle   Fig. 3. Punch and Die for forming the Cone and sizing the Mouth

drawing of the piece is now finished, as shown at *I*, and requires only nickel plating to be ready for assembling.

Notwithstanding the number of operations, the final cost of the stamping is lower than that of the casting which it replaces. The dies for the various operations are not costly and can be quickly interchanged. On account of their simple design the operator is enabled to turn out a large daily output.

* * *

Automobile specialties, good, bad and indifferent, have been developed in large numbers, all having for their objects saving fuel, promoting comfort, saving labor, warning pedestrians, etc. One of the clever wrinkles for saving labor is an impulse air pump which can be applied to any one of the cylinders in place of the spark plug and used for pumping up the tires. The device consists essentially of a small differential piston working in a cylinder fitted with suitable valves. It is operated by running the engine with three or five cylinders, the cylinder to which the pump is connected being dead, of course, because the spark plug is removed. The air compressed in the cylinder is driven through the pipe connecting with the differential piston and drives it upward. The small piston connected to the larger piston compresses a small charge of air to a higher pressure and forces it into the tire. The residual air remaining in the small cylinder "kicks" the differential piston down as the engine cylinder makes its down stroke, the momentum being sufficient to complete the stroke and draw in a fresh charge of air.

RACK CUTTING ON THE PLANER

BY ALBERT CLEGG*

The article entitled "Planing Steel Racks for Frog and Switch Planers," published in the September, 1912, number of MACHINERY, interested the writer very much because his experience in this direction convinces him that the planer, without any special attachments, is almost as efficient when cutting racks as the best fully automatic rack-cutting machine on the market. Furthermore, if a machine were designed along the general lines of a planer but equipped with automatic feed, return and dividing mechanism for the tool-head, the writer is of the opinion that the output from such a machine would be considerably greater than that of a standard automatic rack cutter. Now all this, of course, is mere assertion, but the writer believes he can show that the proposition is a reasonable one. Before doing this, however, it may be of interest if he relates the circumstances which first led him to consider the feasibility of cutting racks commercially in this way.

Some time ago, we found it necessary to replace the rack on one of our largest planers. This rack was of cast iron, 1½-inch pitch by 9-inch face, with a 2½-inch flange on each side to secure it to the table of the machine. (There were five sections, each 54 inches long and weighing about 450 pounds.) The planing of the blanks was, of course, quite an everyday sort of a job which gave no trouble whatever; but when we came to cutting the teeth we "struck a snag." Our gear-cutting equipment included a comparatively light automatic rack-cutting machine, and though we greatly doubted its capacity for doing this work, we decided to give it a trial. The longest work that could be done on this machine without resetting was 42 inches, while the heaviest work previously attempted was cutting 4 diametral pitch in 2¼-inch square mild steel blanks. After getting one of the sections fixed in the machine, we found that the roughing cut on one tooth took fifteen minutes, so that with an equal time for the finishing cut, the actual cutting time required to complete the five blanks would be about ninety hours. While this was pretty bad, the inaccuracy of the teeth was even more serious. The design of the machine was such that when working at the extreme ends of a job, the work-carrying fixture had considerable overhang, and as the planer rack blanks were fairly heavy and 12 inches longer than the machine really admitted, it will be readily understood that this overhang of the work was not conducive to accuracy. We found that the end teeth were 0.015 inch out of square in the width (9 inches) of the blank, and as this inaccuracy was altogether too great, we were forced to the conclusion that it was necessary to employ some other method.

After considering sending the blanks out to be cut and finding that the cost would be $40, we finally decided to try to cut them on the planer—the very machine, in fact, for which we were making the rack. We did not care to rely on the accuracy of the cross-rail screw for spacing the teeth, so we cut a 1½-inch pitch ratchet rack 60 inches in length, and fixed it on the upper side of the cross-rail in such a way that a pawl on the tool-head would engage with it. The indexing was done by moving the head until the pawl dropped into the next space on the rack, and then moving it in the opposite direction as far as the pawl would allow. All the five blanks were bolted on the table of the planer at once, the flanges proving very convenient for this purpose. The spaces were then stocked out by using two ½-inch grooving tools, placed side by side and, of course, of 1½-inch pitch. The cutting speed was about 25 feet a minute and the feed per stroke 0.015 inch, the time taken to rough out two spaces in the five blanks being about eighteen minutes. After all the teeth had been roughed out in this way, a form tool having straight sides with an included angle of 29 degrees was used for finishing. A dead stop was set on the tool-head to give the exact depth of tooth; the automatic feed was used until the tool was just short of full depth, when the automatic feed was disengaged and the last few cuts were fed by hand until the stop was reached. Of course, it will be understood that this method was followed for the roughing as well as for the finishing cuts.

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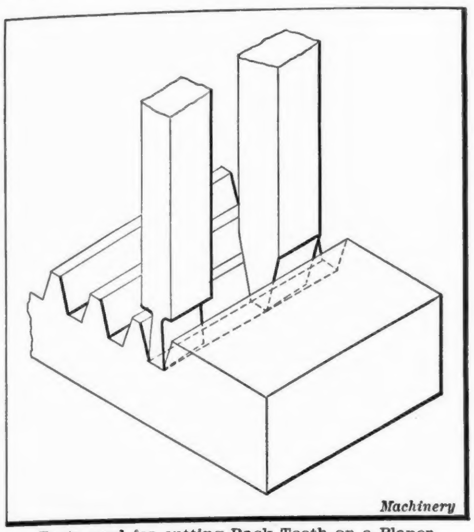
The feed and speed for finishing were exactly the same as for roughing, so that the time required to take a finishing cut was eighteen minutes, five teeth being finished in this time. The roughing time for one tooth was:

$$18 \div 10 = 1.8 \text{ minutes}$$

and the finishing time

$$18 \div 5 = 3.6 \text{ minutes.}$$

This made the total time only 5.4 minutes or less than a fifth of the time required by the rack-cutting machine. Including the flanges and allowing for two cuts at equal rates of feed, a milling cutter would require a feed of 5 inches a minute to equal the above performance. It appears that the above description is sufficient to show that the planer is by no means a "makeshift" for cutting rack teeth; indeed, its output compares so favorably with the usual method that it may possibly make the latter appear to be the "makeshift."



Tools used for cutting Rack Teeth on a Planer

Some time ago the writer came across a price list of mild steel machine-cut racks, and among other items listed were 7-, 8- and 10-pitch racks made from 1⅛-inch square, drawn-steel bars; the price quoted for such racks was 30 cents a foot. Now on the face of it, this price seems extraordinarily low, but a little figuring will show that, using the proper equipment, a fair profit is possible even with the very low price quoted. The stock used is drawn steel bar costing, roughly, 10 cents a foot. No machining is done on the blanks, except cutting them from the bar. If we allow the rather large margin of 2 cents a foot for cutting off, the total cost of the blanks, ready for cutting, will be 12 cents a foot. This leaves 18 cents a foot to cover cutting the teeth, overhead charges, wages and profits. If we base our estimate on the 10-pitch size, it means that there are:

$$12 \times \frac{10}{\pi} = \frac{120}{3.1416} = 38.2$$

teeth to cut for 18 cents, which works out roughly at 0.5 cent per tooth. How, then, can this work be done at such a low figure and a profit be made on it?

The method suggested by the writer would be by means of a special planing machine to take work up to about 36 inches wide, 18 inches high and 48 inches long. This machine would require an arrangement for automatically feeding, returning and spacing the tool-head, and also a pump to supply lubricating fluid to the tools. The table should have a suitable vise-like fixture for carrying the blanks; this fixture could be arranged so that blanks might be set over the entire length of the stroke of the machine. At three or four places in this length, it would probably be necessary to have supplementary jaws bolted to the base of the fixture to minimize, as far as possible, the tendency for the blanks to lift. The tools would be similar to the ones shown in the illustration, but on such a fine pitch as 10, there would be at least two pairs of tools operating on two spaces simultaneously. A brief description of these tools may not be out of place. The front tool is really for roughing, and is arranged so that it only cuts on the end, while the rear tool, which is for finishing, clears the bottom by one or two thousandths, and therefore only cuts on the sides. This enables fairly heavy cuts to be taken. The writer has used this arrangement for all kinds of grooving in steel with very satisfactory results, and has no hesitation in recommending it for this class of work.

To return now to our calculation, we will assume that twenty blanks are mounted on the machine at once. Allowing for the width of the supplementary jaws, this will require a stroke of about 36 inches. Assuming a cutting speed of 45 feet per minute and a return of 90 feet per minute, the number of strokes per minute will be

$$\frac{1}{3/45 + 3/90} = 10$$

If we allow for a feed of 0.01 inch per stroke, the number of strokes required to cut a 10-pitch space would be:

$$0.216 \div 0.01 = 21.6.$$

Some idle strokes will take place during the returning and the indexing period, so we will increase this to 25 strokes; 25 strokes at 10 strokes a minute means that it will take 2.5 minutes to completely finish 40 teeth; this makes the rate of production 960 teeth an hour. The cost of production is 0.5 cent a tooth which gives $4.80 as the value of one hour's work. It will be conceded that this sum allows a reasonable margin for overhead expenses, wages and other incidental items, leaving a fair profit after all these charges have been met. In addition, it shows what is possible with a machine designed along the lines suggested.

The writer would like the author of the article "Planing Steel Racks for Frog and Switch Planers," which appeared in the September number of MACHINERY, to explain how they managed to make the ⅝-inch roughing tool stand up under a feed of 0.04 inch per stroke in forged steel. So far as our experience goes, this is an abnormal feed for a grooving cut. The writer would also like to draw his attention to the double tool arrangement shown in the illustration which would, in his opinion, not only do the work with less strain on the machine but would probably enable them to do in two cuts what is now taking four. The finishing tool in any case ought to be arranged so that it does not cut on all three sides. This will considerably reduce the tendency to chatter without being in any way detrimental to either the strength or the running qualities of the finished rack. There is no reason why the depth of the spaces made by the roughing cuts should not be even 1/64 inch deeper than standard. This is unnecessary, however, as all that is required is for the finishing tool to clear the bottom of the space when taking the last cut.

* * *

SKETCHING OF MECHANISM IN DESIGNING

BY FORD W. HARRIS*

The usual method of designing mechanism is to let the designer lay it out himself or a competent draftsman do it under his supervision. The technique of mechanical drawing is well understood and very little can be said at this late day about the special methods that have been developed for making accurate and economical layouts. It is sufficient to say that a good layout is an accurate drawing which shows the essentials of the device to be detailed without going into all the details and without attempting to produce anything ornamental. It is a drawing reduced to its lowest terms. Most inventors start with such a layout, generally made for them by a draftsman.

The writer has to date placed about fifty patent applications in the Patent Office, and about thirty patents have issued, nearly all of which are for mechanisms, and perhaps a brief description of his methods of inventing a mechanism may be of interest. They have been developed during sixteen years practical experience on such work, during which time the general methods outlined have been applied to work varying from a ladle tilt in a steel mill to a regulating mechanism of an arc lamp. It is probable that they do not differ greatly from those used by other men in the same work, but the writer does not remember ever seeing such methods described and, although he has been associated with a number of inventors, he does not remember many who have developed the system quite as fully as he has. The completeness of this development is due to one fundamental belief that may as well be expressed as a starter.

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This belief is that no man calling himself a designer should ask another to draw something that the designer has not satisfied himself in advance is possible and very likely to be practical. This is at variance with the practice of many designers who make a very rough sketch or do what is worse, describe what they have in mind and let the draftsman worry it out. This is very economical of the designer's time as it leaves him free to carry on other work, but it is wasteful of the draftsman's time, and generally results in inferior designs. It is the writer's opinion that the designer should personally carry his work to such a point that the draftsman can go ahead and complete the work with very little help or attention from the designer, and further, it has been demonstrated that if the designer will so handle his work the result will be a considerable saving in cost, considering both the designer's and the draftsman's time.

To do this the designer must roughly lay out the work himself and satisfy himself that what he has in mind will go together. This can be done by the usual drawing office methods, but such methods are too accurate and slow for the purpose in mind. What is desired is a collection of sketches and a description or specification that the draftsman can take and go ahead on, without having to lay out a half-a-dozen schemes before he finds an acceptable one. Of course, designs are generally the work of a number of men, but the original inventor will find that if he digests his schemes pretty well before he starts to get others working on them he will generally carry them pretty near to perfection, and the time of the others will be saved.

It may be necessary to spend a lot of time and hard thought to do this, but very little that is good in engineering comes easy. It will be found that the excellence of any design is a direct function of the time and hard work that has been put upon it. It is not possible to dispense with the draftsman's layout and such a layout will probably disclose difficulties that the sketches will not discover, but such difficulties will be very much smaller in number and of a very much less important character than when the draftsman starts out with only a very hazy idea of what is wanted and the designer has even less accurately defined notions. It is merely a practical application of the old principle that whatever is worth doing at all is worth doing well.

If the design is a hard one it is very unlikely that a satisfactory solution can be found without several trials. If these are made on the drawing-board it will take a lot of time, while by using the sketch method the impracticability of the simple solutions will be quickly apparent and they can at once be discarded without serious expense or what is often of more importance—serious delay.

A man who is going to dig in hard with his brain should have as little strain on his body as possible, and it is a pretty hard job physically to bend over a drawing-board. It is preferable to do the work at an ordinary desk in an ordinary swivel chair which is about as comfortable a position as can be devised. This at once eliminates big sketches, and it is desirable to make them standard letter size which is generally regarded as 8½ by 11 inches. Secondly, it is desirable to use a cheap grade of stationery; the writer uses cheap white typewriter paper for the preliminary work, and tracing linen for the final result. The paper sketches are finally thrown away. The final result is valuable, and it is desirable to save it as it is of value in patent litigation so that the very best is none too good. Intermediately a few sheets of tracing paper will come in handy, but such paper is perishable, tearing easily, and a thin bond paper is much better.

Many designers use ruled cross-section paper, which has two objections: First, it is expensive, and second, after the sketch is made it is better to put in a few main dimensions and not have cross-section lines to confuse the lines of the sketch. It is preferable to make an underlay sheet on tracing linen and use ordinary paper, laying the cross-sectioned underlay under the white paper, and thus have the cross-sectioned lines to make the sketch by but not have them on the sketch itself. Do not use a fine cross-section; the writer finds that half-inch squares give excellent results. Quarter-inch squares are also good, and two sheets one ruled in halves and the other in quarter-inch squares will serve to lay out almost any sort of a small mechanism.

The first thing necessary is a sketch of the fundamentals to give a rough idea of the best arrangement of parts. This the writer ordinarily makes on a poor grade of paper and does not bother about the underlay. All that is needed is a qualitative idea of the mechanism without much regard to size of parts, interferences or details of construction. It is not always easy to draw this first sketch, and one can spend much time in groping around for an inspiration. The best way to do, then, is to seek for inspiration from similar mechanism. We are all of us moving by slow steps and he is indeed a conceited man who will not admit that much of the fine work he puts out was borrowed from the long procession of similar designs that have gone before. It is a good principle to take your own wherever you find it, and if some one has seen it first so much the more credit it is to them. This is, of course, to be modified by considerations of general principles of business and common honesty, but in general there is no such thing as an ownership of mechanical combinations, or at best only a limited ownership for the term of a patent.

After having produced a rough sketch that looks meritorious, it is advisable to make a sketch showing the principal parts to scale within the limits of free-hand sketching. Here is where the underlay and the thin bond paper come in handy. A small pine board and a celluloid angle with a few thumb-tacks are all the drawing instruments needed, and with the underlay sheets and these accessories quite presentable sketches may be made. Pin the bond paper down to the board with the underlay under it and draw in the principal parts with a soft pencil without bothering about one part cutting off the view of another. That is, lay in every piece as if it were the only piece on the sheet and do not bother about dotting or omitting lines that would not appear on a true view of the mechanism.

Before going very far, the designer will begin to wonder what is going to happen when some of the parts assume another position than that in which he is drawing them. The best way to find out is to take a scrap of tracing paper or linen and make the part on this separate piece. This scrap can then be slid around and its action noted. It may be desirable to preserve a record of such positions and a separate sheet of bond paper may be started to show the relation of the mechanism at various points, a separate sheet being generally used to show each position. No attempt should be made to show fastenings.

After a lot of juggling the design begins to breathe or it doesn't. If it doesn't it is generally best to make a fresh start, preserving the papers and the scraps pending the failure or success of this start. After several trials a layout will be evolved that seems to be satisfactory. It is now in order to make the final sketches from the several sheets and scraps that have accumulated. Take a sheet of tracing linen and a soft pencil and trace in free-hand from the scraps the various parts with due regard for their position, dotting important hidden lines and omitting unimportant ones. This final sketch is made only partly for the information of the draftsman. Its chief value is to show whether the work will stand the test of an assembly sketch. Very often it will not and the designer will have to make a fresh start or modify his sketch to avoid the difficulty.

When the designer is through he should have some pencil sketches on letter size tracing linen that fully express the work that he has done. Very often he will do in a few hours what would take as many days to accomplish working cut-and-try with a draftsman, and the chances are that he will have applied himself so that the quality of the work is much better.

* * *

"Fighting one's way to the top," says one of our contemporaries, is an expression that carries too much of the spirit of warfare and antagonism for an age when it is more and more being recognized that cooperation and work for the common good is the primary requirement. Why not then say "working" instead of "fighting?"

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

GENERATING THE SKEW BEVEL GEAR

The January number of MACHINERY contained an article entitled "A Practical Form of Tooth for Skew Bevel Gears," by George M. Bartlett, which was very interesting to me. I believe that Mr. Bartlett is the first to publish anything regarding the fact of the generating rack for skew bevel gears being a *right helicoid*. I have held essentially the theory which Mr. Bartlett so ably advances, for a number of years, and have recently succeeded in actually cutting a pair of such gears by the theoretically correct generating process; this proves that Mr. Bartlett's theory is correct, except in regard to what he says about "under-cutting."

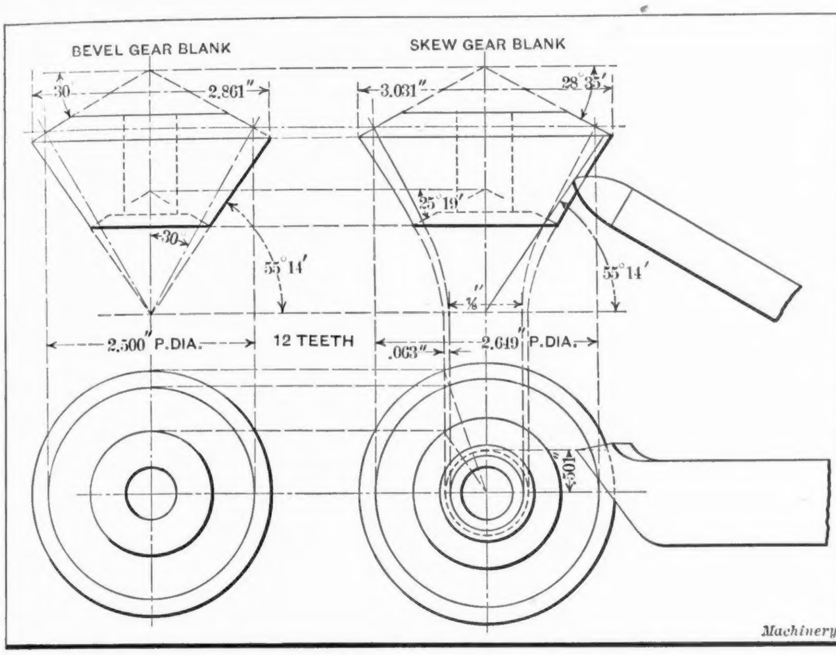


Fig. 1. Turning the Blanks for Skew Bevel Gears and Regular Bevel Gears

Owing to the lengthwise sliding or slip—if it may be so called—I expected that the tooth outline of the skew gear would differ from that of the corresponding bevel gear, and to bring out its peculiar features as clearly as possible I have made a pair of gears which extend as near to the gorge circle of the hypoid as could be conveniently cut with my present facilities. The dimensions of these gears were as follows:

Largest pitch diameter = 2.649 inches.
Angle of asymptote = 30 degrees.
Number of teeth = 12.
Width of gear face = 1.25 inch.
Diameter of gorge circle = 0.875 inch.

From this data the pitch of the imaginary helicoidal rack figures out 4.761 inches.

The hypoid form of the blanks was turned with the tool simply set half an inch above the center, and with the compound rest set to the same angle at which it would have been set for turning the corresponding bevel gear blank. The method of turning the blanks will be readily understood by reference to Fig. 1. Figs. 2 and 3 show the first gear after cutting the teeth. Although a pressure angle of 20 degrees was used, there is not only a considerable under-cutting—which is all on one side of the tooth—but the tool also cut away material on the same side of the tooth at the top; the effect on the opposite side of the tooth is just the reverse so that it will be apparent that the tooth outline is decidedly unsymmetrical. Reference to Figs. 2 and 3 will show the reader the amount by which the tooth outline differs from a symmetrical form. From the study which I have made of this subject, I believe that this deviation from a symmetrical tooth outline will be most pronounced at some point near the gorge circle, that beyond the gorge circle these conditions reverse so that excessive under-cutting will then appear on the opposite side of the tooth.

In the case of the gears shown mounted on studs in Fig. 4 this excessive under-cutting has been avoided by changing the pressure angle on one side to 25 degrees, but with the apparatus which is now at my disposal, I could only do this by simultaneously changing the pressure angle on the other side to 15 degrees. This produced a somewhat "leaning tooth," but what under-cutting there is on each side is only trifling in its amount.

Skew bevel gears find application in various kinds of machines, but nearly all of these gears are now cast from patterns, while even the best of cut gears of this type which the trade can so far supply, are far from being good approximations, but the present method of generating teeth should afford a means of producing skew bevel gears which, in point of accuracy, and consequently smooth action, would be equal to generated bevel gears. Where the distance between the shafts is great enough to make the gorge circle very large, it will usually be possible to use other forms of gears; but when this distance is only great enough to allow the shafts to pass each other, thus requiring the gorge circle to be small, as is frequently the case, skew bevel gears are the only form of transmission which will answer the purpose.

Fig. 2. The First Skew Bevel Gear produced by the Generating Process

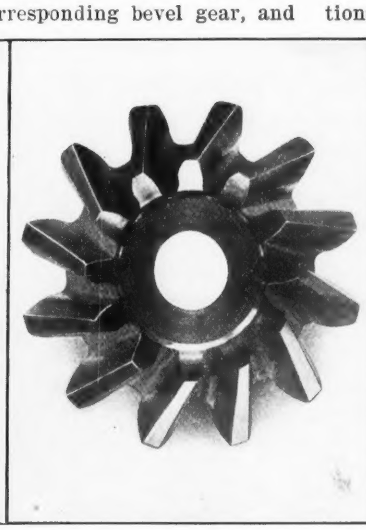


Fig. 3. Front View of Gear shown in Fig. 2; compare the Tooth Outlines

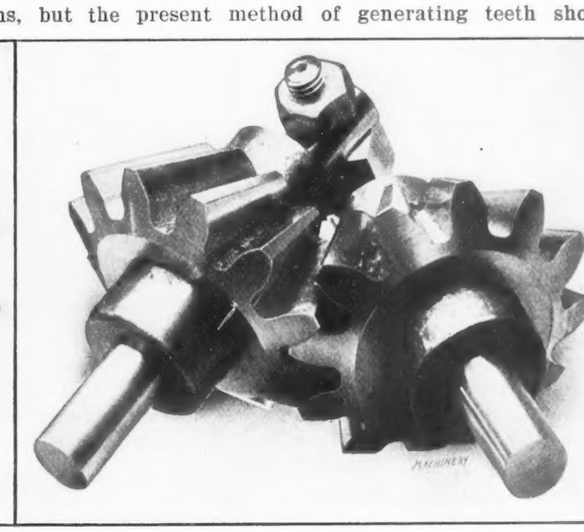


Fig. 4. A Pair of Uhlmann Skew Bevel Gears in Mesh

Philadelphia, Pa. MAX UHLMANN

DO BELTS RUN TO THE HIGH SIDE?

The writer has been much amused at the different ideas which have been published on the subject "Do belts run toward the high side of the pulley" when the shafts are out of parallel. It is certain that a belt behaves in approximately the same manner for all of us, and the varied experiences which have been reported arise from the confusion in the use of common mechanical terms. In the article in the January number of MACHINERY it was shown by George P. Pearce that the belt runs off on the low side of the pulley. This is undoubtedly true, but in so doing it is running *toward the high side* when it runs off the pulley on the *low side*. The writer uses the diagram which appeared in connection with Mr. Pearce's article to prove the accuracy of this statement. In this sketch the belt is shown running toward the high side of the pulley, but this action causes it to leave the pulley on the low side.

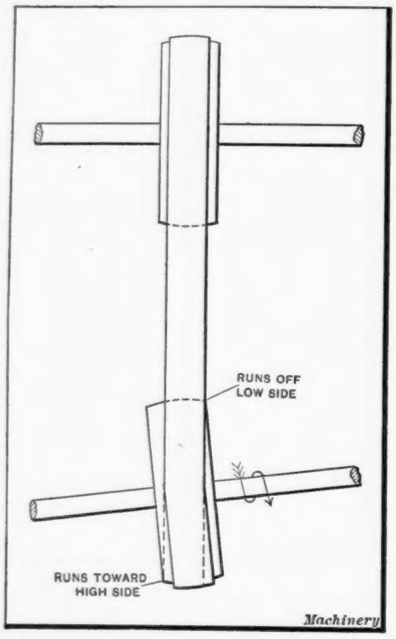


Diagram showing how a Belt runs off the Pulley when Shafts are out of Alignment

Troy, Ohio HENRY J. BECK

"SPECIALISTS WHO DO NOT SPECIALIZE IN PRICES"

The editorial in the February number of MACHINERY entitled "Specialists Who Do Not Specialize in Prices" was read with interest by the writer, who for several years past has been associated with a firm specializing in ball bearing manufacture, and as it is difficult to believe that this was written by one who had made a thorough study of conditions relating to ball or roller bearing manufacture, some discussion relating to this subject may be of interest.

No exception can be taken to the editorial statement that a number of machine tool builders are making their own bearings economically, and in many cases these are giving good satisfaction, but they are not made on standard machine tools with a few special jigs and fixtures as you state. In order to compete successfully with a specialist, it is necessary to have as complete an outfit of machinery, though on a smaller scale, and when initial investment is considered it is seldom that bearings are made in a machine manufacturing establishment as cheaply as they can be purchased, providing they are similar to regular standard stock produced by the manufacturer of anti-friction bearings.

The writer is connected with the machine tool branch of the engineering service department of one of the leading ball bearing manufacturers (New Departure Mfg. Co.), and it is my belief that statements made in editorials are not based on actual experience. In nearly every case where we have been unable to quote satisfactory prices, the machine manufacturer wished small lots of special bearings that in many cases were proportioned so poorly and with so little regard for ball bearing engineering principles that we would not make them even if we had jobbing facilities available.

When manufacturing thousands of ball bearings per day the proposition of introducing the undesirable element of special work of a jobbing nature is not pleasing, so prices are always made sufficiently high to pay for tools, special fixtures and inconvenience entailed by loss of regular production capacity. A few special orders of bearings that differed from the standard stock product would introduce complications that would not be realized by one not familiar with anti-friction bearing manufacture. In our plant, for instance, all bearings are inspected thirty-one times before shipment. The confusion produced by introducing a small special lot of bearings differing from the product can be multiplied by every manufacturing process they must go through, and the seriousness of this in a plant where orders are always ahead of capacity can be easily understood by considering the thirty-one inspections alone. On such bearings we believe the prices asked are justified.

When one considers the wide range of standard sizes and types of ball bearings available, it is difficult to understand why the machine tool manufacturer must use special designs. The firm with whom the writer is associated manufactures nearly two hundred distinct sizes of bearings, these being divided into three standard types. The bores range from approximately 3/8 inch to nearly 4 1/2 inches, the outer diameters from 1 inch to 9 inches. Ball sizes ranging from 3/16 inch to 1 1/2 inch may be obtained, and carrying capacities range from 160 pounds to 15,000 pounds at 600 revolutions per minute. A machine tool manufacturer who cannot make a selection of bearings that will fit his requirements from such an assortment is certainly hard to please, and the only way he can be satisfied is undoubtedly by building the bearings he thinks he needs to suit himself.

The machine tool manufacturer is seldom a gainer by doing this, however, because the building of practical ball bearings is essentially the work of specialists. Some manufacturers deceive themselves to the extent of believing that their product is equal to that manufactured by a specializing manufacturer, but this is seldom true. The writer has carefully examined many such samples submitted for quotations and has never found one equal in design or finish to those produced by specialists. Balls were found to have soft spots, to have entirely decarbonized surfaces, to show a coarse fracture and lack strength when broken, and to vary from sphericity or adherence to standard size by 0.001 inch and even 0.002 inch. The finish on many home-made balls and races showed the grinding marks plainly, and the only balls that were found properly treated were the products of specialists, because they showed characteristic fractures that easily classified them. Cones were found with races of poor curvature and improperly treated. Some of the cones submitted had a raceway with a curve made on a radius equal to ball diameter so the ball could not possibly have a true rolling motion. Others had straight angular raceways that are deficient in carrying capacity. Most cones did not have sufficient metal under the balls, and it was seldom that the bores were not ground bell-mouth and to some irregular size, if ground at all.

Cups were made of pressed steel in many cases, with merely a cyanide hardening and with polished raceways that were finished by some rough lapping process instead of the correct curve generating grinder. The metals were seldom suited for the work, and were usually very carelessly treated. Some cups had a three-point contact and were used with a two-point contact cone so the balls were subjected to a spinning and rubbing action all the time they were in use, and in fact some of the bearings received were so tight that more power would be required to turn a shaft mounted in them than would be needed on plain journals with indifferent lubrication. Some of the pressed steel cups were out of round 0.004 inch or 0.005 inch, and cones were out of round and distorted by hardening fully as much. The lapping process used to polish the raceway did not make the raceway true, as the lap followed the cone or cup contour, whereas the proper type of grinder would have generated a raceway of proper curvature. Most of the bearings submitted used small balls and were of the full type without separators. Some had apparently been run long enough to have banded and scored the balls, and most of them were of the type that fell apart as soon as handled, the balls scattering to all points of the compass. Roller bearings were also examined carefully, and in all cases the workmanship was even more crude and the finish poorer than was found in the ball bearings. These were the bearings machine makers were making in many instances and thinking that they were saving money because they cost less than the product of specialists.

Ball bearing manufacturers have been through the mill, and the difficulties that machine tool manufacturers who make their own bearings are just being confronted with have been overcome years ago. If a manufacturer is satisfied with a cheap product he certainly can compete with specialists, but he can not produce goods of equal quality at the same cost.

Consider the balls used in good annular bearings. These are not allowed to vary from standard size more than 0.0001 inch in any one bearing and are absolute spheres to that close limit. The heat-treatment has been carefully determined by exhaustive laboratory tests, and balls are hardened by the aid of delicate instruments and under the supervision of competent metallurgical engineers. The surface finish is so fine that grinding marks are not visible even under the usual magnifying glasses and show up only when examined under a microscope. The machine tool manufacturer cannot produce balls of this kind to compete with the specialist. Even if he has part of the costly general equipment he is not justified in securing the services of the expert metallurgists available to the specialist, and he surely cannot use the patented, special machinery employed by them in ball manufacture.

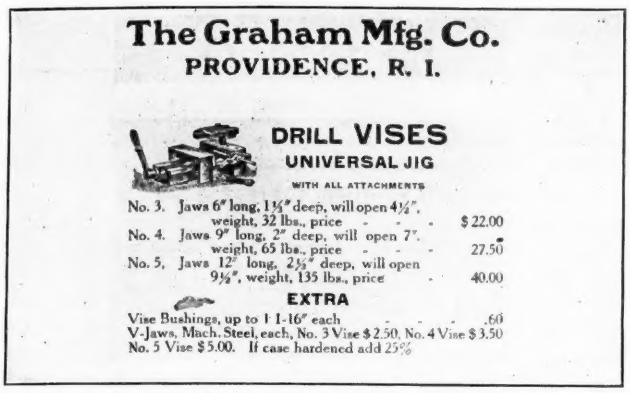


Fig. 1. Drill Vise Card from File kept for the Graham Mfg. Co.

The writer of the editorial in question says standard machine tools and a few special jigs and fixtures are all that are needed to produce ball bearings commercially. A visit to any anti-friction bearing manufacturing establishment will soon dispel this idea. In the plant the writer is most familiar with, hundreds of standard machines are used, but these are roughing out the work and seldom finishing. The accurate work on cups and cones is being done on special machinery developed by the engineers who are specializing on ball bearing manufacturing solely and whose entire time is spent in experimentation and research work that means a constant refinement in processes of manufacture, making for economical production. The machine tool maker could not afford to maintain this staff of specialists; he could not use the special machinery, which is patented in most instances, and he certainly does not have the data resulting from the research of men specializing in ball bearing production to guide him.

When these facts are considered it will be apparent that either quality or correct design must suffer when anti-friction bearings are made by general manufacturers. The writer can demonstrate very clearly that any manufacturer who can use the standard product of ball or roller bearing producers is no more justified in making his own anti-friction bearings than he is in making his own taps, dies, twist drills, gear cutters, micrometers, scales, emery wheels or any of the many other standard parts he can purchase more cheaply from a specialist. If he needs special drills or cutters and only in small quantities, he must make them himself, and that is the only time he is justified in so doing.

No matter what the quantities are, so long as the product is standard and in course of regular manufacture, no machine tool manufacturer, no matter how well equipped he is, can compete with the specialist and produce goods of equal finish, quality and general excellence at the same cost.

In answer to the editorial writer's query about the cost of selling ball bearings, the writer wishes to state that the cost of selling ball bearings, owing to the large number generally sold to a customer, is much less than that of most machine tools and shop appliances. These have been ordered in lots of 200,000 and 300,000 from the firm with whom the writer is associated, by automobile manufacturers, and even machine tool manufacturers, who have just started using these bearings in quantities order in lots of several thousand. The high cost of special bearings is not due to selling cost, but because it is impossible for a ball bearing manufacturer to become a general jobber without ceasing to be a specialist.

Bristol, Conn. VICTOR W. PAGE

[The editorial in question did not state that machine tool builders were making balls, and it was not the intention to convey the meaning that they were doing more than making the bearings. Motorcycle builders, however, are making the rollers as well as the bearings.—EDITOR.]

MACHINERY AND TOOLS DATA CARDS

In getting out a buyers' directory, the Patterson Tool & Supply Co., Dayton, Ohio, has adopted the use of standard 3- by 5-inch index cards on which are pasted slips bearing the name of the buyer, and a list of tools and other factory supplies. These cards can be readily filed and give information concerning the class of supplies for which the customer is likely to be in the market. It appears that many manufacturers could get up cards of this kind at a very small expense and send them not only to dealers but to manufacturers. Such cards should be of sufficient value to prevent them from being consigned to the waste-basket.

Fig. 2. Drill Speeder Card from File of the Same Company

Dayton, Ohio THE PATTERSON TOOL & SUPPLY CO.

SUGGESTIONS ON TOOLING FOR INTERCHANGEABLE MANUFACTURE

In the December, 1912, issue of MACHINERY, "A. L. B. Co." asks about the best method of procedure in tooling for interchangeable manufacture. As the editor very correctly answers, there is no general agreement among manufacturing experts in this regard. However, it seems to the writer that one general statement could be made which would apply to every concern undertaking interchangeable manufacture, *i. e.*, such matters should be "threshed out" and decided in the drafting and tool-designing departments of the company interested. The writer is assuming that any company engaging in interchangeable manufacture has at least one competent draftsman, who, by conference with the shop superintendent and heads of departments, would be capable of collecting and developing all the good ideas relating to the tooling and manufacture of any machine taken under consideration. All machinery manufacturing experts agree that time and expense are not lost when devoted to thoroughly working out such matters on the drawing-board.

Granting that the reader is not averse to considering the part the drafting-room should play in tooling for interchangeable manufacture, let us investigate a few facts which have come to the writer's notice in such cases. It very often happens that a machine is made or built—"thrown together" is a better expression—for a number of years before a company will manufacture it so that the parts are entirely interchangeable. Then a designer is called in and the machine is properly "laid out" and detailed. More often, the various details of the machine are "measured up," and detail draw-

ings are made from the parts themselves. In the writer's opinion, this method is always a mistake. In one such case, a machine had been built for a year or more without making any provision for having the parts interchangeable. It was decided to provide a complete equipment of jigs, fixtures, gages, etc. A draftsman measured the parts, and was instructed to make drawings of them just as they were. The result was a most magnificent collection of odd shapes, fancy dimensions, foolish limits, and mongrel threads, tapers, etc. This was partly due to the draftsman's inexperience, but it was chiefly the result of the method that he followed in doing the work. Then came taps, reamers, and other small tools that were of no standard design, necessitating the production of special small tools as long as the machine was manufactured. Jigs and fixtures made from the pieces, or from the drawings of the separate details, turned out work that failed to "match." A number of these tools had to be discarded, some of them costing several hundred dollars.

When it was necessary to make tools for a similar machine, an entirely different system was adopted, resulting in a highly efficient means of tooling. When this machine was considered to some extent standardized, detail drawings were made from the original assembly, which had been corrected to date. These were checked, and turned over to men familiar with the functions of the machine and the requirements of manufacture, for the assignment of limits. And this matter of limits, as is well known by every man in the mechanical field, is a subject of the utmost importance in interchangeable manufacture. The use of mechanically and mathematically correct limit gages is often the means of swinging a manufacturing proposition from a losing to a paying basis. With the assignment of correct limits to the various machine parts, and a careful checking of the detail drawings, one feels safe in proceeding to design jigs and other tools from these drawings themselves.

Another means of checking the detail drawings, if one is so inclined, is to have a draftsman make an assembly drawing of the machine in question, using dimensions as given on the detail sheets. This serves as a final check, except in the case of very close dimensions, and often is a considerable aid in exposing errors which might not otherwise be found until it came to assembling the machine from the finished parts. Where competent draftsmen are employed, and thorough cooperation is required between the drafting, manufacturing, and tool-making departments, the writer maintains that the drafting-room can be of invaluable assistance in the very important matter of tooling for the interchangeable manufacture of any machine. T. D.

MILLING FIXTURE FOR A GUN PART

The accompanying illustration Fig. 2 shows a milling fixture for milling the gun part shown in Fig. 1. The cross-section at *A* shows the piece after having been milled. The tools used in gun work must produce very accurate work,

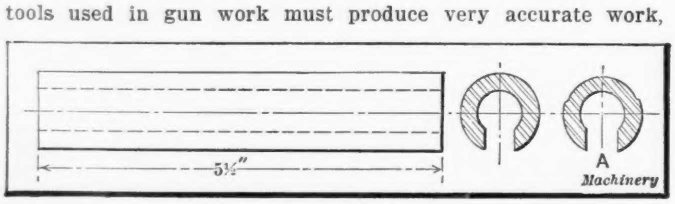


Fig. 1. The Part to be milled

and, hence, the features of this fixture will undoubtedly be found of interest. The base *A* of the fixture is fastened to the machine table by the usual tongues and by a large bolt *B*. Separate from the base and secured to it by screws *C* is a body casting *D*. This body casting has four V-slots milled in it at an angle of 5 degrees from the horizontal. Castings *E*, of which there are four in the complete fixture, but of which only one is shown in the engraving, contain the locating and clamping devices for the work. These castings slide in the V-slots in the body casting. The work-holder castings *E* can be adjusted independently of each other by screws *F* and check-nuts *G*. The screws *F* bear against the large studs *H* driven into the body casting. It is thus possible to secure exact duplication of the work in each of the four work-holder castings, even if there should be a slight variation in the diameters of the cutters.

When locating the work, it is laid on the block *J* and the tongue *K* engages the slot in the part to be milled. One end of the work bears against stud *L* and is clamped in position

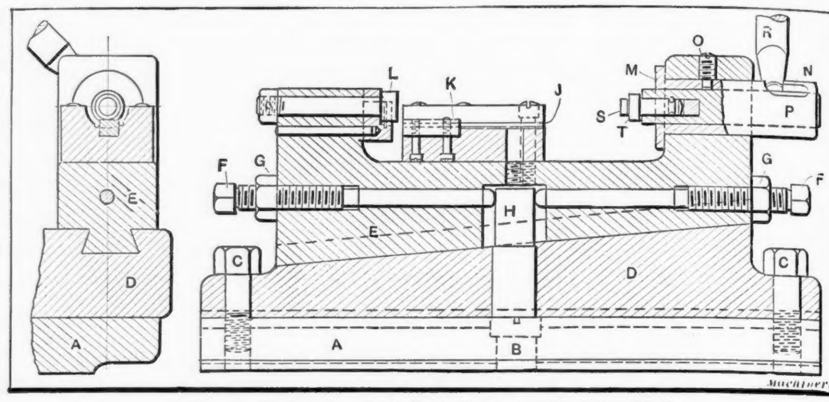


Fig. 2. Fixture in which Part shown in Fig. 1 is milled

by a quick-acting clamp consisting of a bushing *M* having a slot *N* in it. This bushing is prevented from turning by a set-screw *O*. In the bushing is a plunger *P* which is moved forward by handle *R* to engage the work, and backward when disengaging. In the end of the plunger is a shoulder-pin *S*, the small diameter of which enters the hole in the work and the shoulder *T* of which bears against the end of the piece to be milled. J. Card

UNUSUAL METHOD OF SUPPORTING LATHE SADDLE

An interesting type of 19-inch high-speed lathe was exhibited at the Olympia Exhibition by the Judson-Jackson Co., London, on behalf of Messrs. Schaerer & Co., Karlsruhe, Germany. The interesting feature of this lathe is that the top of the bed is only used to carry the headstock and tailstock; the saddle is not carried on the top surface of the bed in the

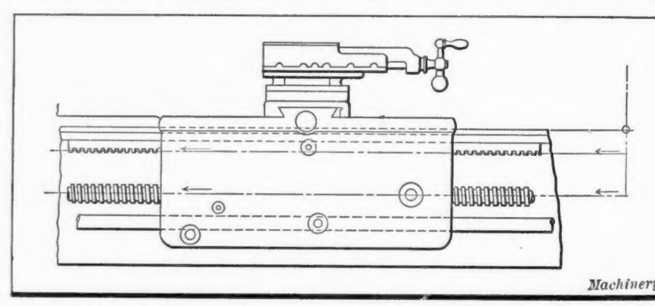


Fig. 1. Usual Method of supporting Lathe Saddle on Bearings at the Top of the Bed

usual way but slides on vees on the sides of the bed. It is said that having the shears at different heights counteracts the tendency of the saddle to lift. It will be noticed that this arrangement brings the lead-screw above the point of support, instead of being considerably below it, and this design greatly reduces the tendency of the saddle to twist.

Figs. 1 and 2 illustrate the direction of forces acting on a lathe saddle supported in the customary manner and in the Schaerer construction. Comparing these illustrations, it will be seen that in the usual lathe construction shown in Fig. 1 the pull on the saddle exerted by the lead-screw and the thrust on the tool-rest from the tool unite to give a maximum twisting moment in the saddle, this being due to the fact that the saddle bearing which forms the fulcrum of these forces is between their points of action. In Fig. 2, however, it will be seen that the opposite conditions exist, that is, the saddle bearing or fulcrum of the forces set up is below the lead-screw. Hence, in the later design, the moment due to the thrust of the tool on the rest is opposed and partially neutral-

ized by the moment of the pull of the lead-screw on the saddle. The saddle travels clear of the top surface of the bed and in the larger sizes, such as the 35-inch and 43-inch swing lathes, in addition to these two slides on the sides of the bed, the saddle has an additional slide at the center of the bed. As

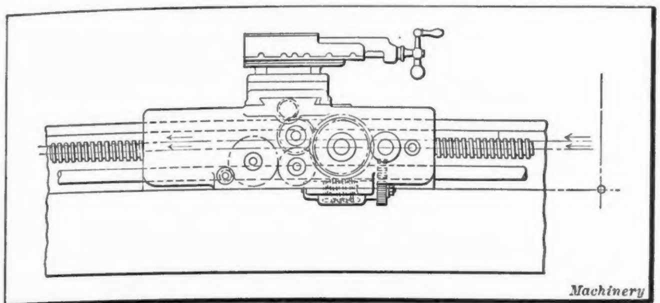


Fig. 2. Schaerer Bed Construction with Saddle Bearings on Side of Bed

the slides are underneath the shears, they are protected from chips and dirt, and while the saddle overhangs the gap there is no reduction whatever in the bearing surface. In Fig. 3, the diagram at the right-hand side represents the usual practice in lathe design, while the diagram at the left-hand side

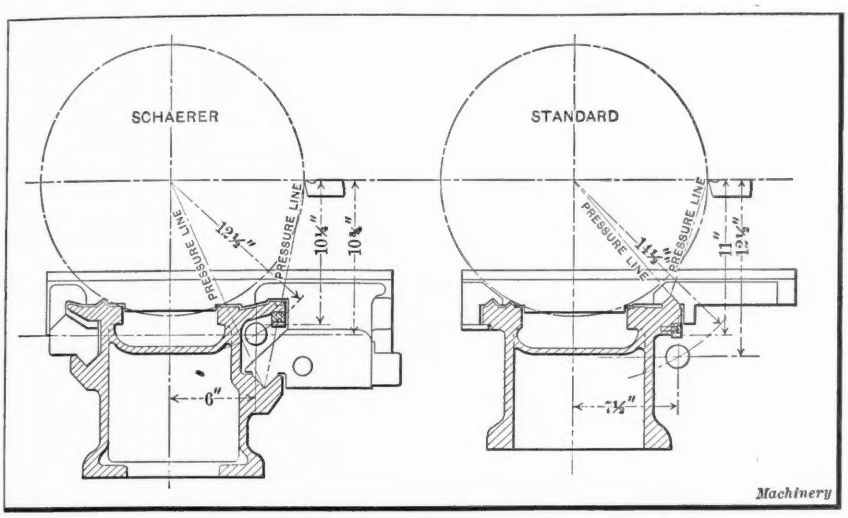
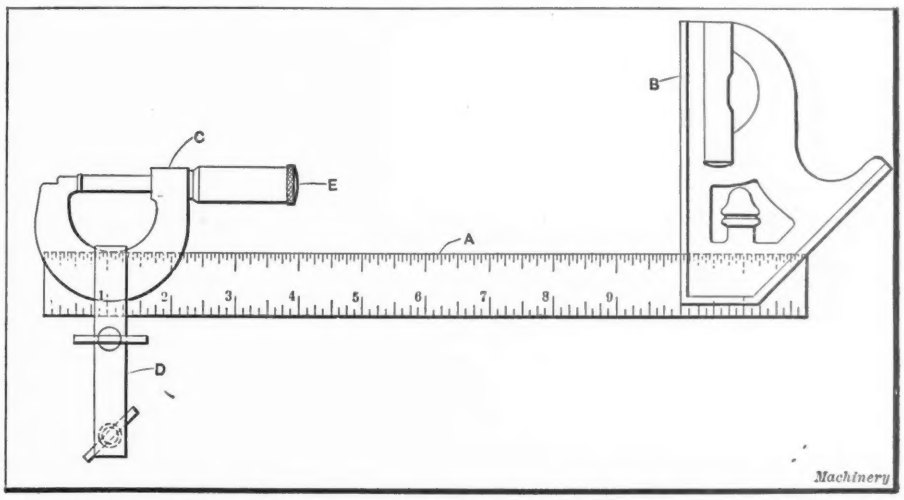


Fig. 3. Cross-section Views of Standard and Schaerer Lathe Beds

shows the Schaerer construction, and this gives the necessary comparison without further comment. J. A. S.

USING A SMALL MICROMETER FOR LARGE WORK

Occasionally a large micrometer is required to measure flat work, and very few machinists are fortunate enough to possess a micrometer larger than the 3-inch size. The illustration shows three tools which are found in almost every machinist's tool case, and the method of combining these tools to afford a means of making measurements to 0.001 inch on work up to six inches in size. It will be seen that the parts *A* and *B* are an ordinary 12-inch scale and combination square. The micrometer *C* is placed at one end of the scale and held firmly in position by the parallel clamp *D*. The stock of the combination square is fixed to the scale in the usual way. The illustration shows the stock placed in position for measuring work between 5 and 6 inches in size. When the micrometer is unscrewed, the thimble *E* approaches the stock *B*. The work to be measured is placed between the thimble and stock and when the thimble comes into engagement with the work, the reading of the micrometer is taken; this reading is subtracted from 6 inches in order to get the dimension of the work to 0.001 inch.



Combination of 1-inch Micrometer and 12-inch Combination Square adapted for making Measurements from One to Six Inches in Thousandths of an Inch

In assembling this tool, a six-inch end gage may be used to locate the stock *B* and the micrometer *C* in the proper relation to each other. It is evident that the same method can be used for measuring work from 1 to 6 inches in diameter. The only additional equipment required is the end gage for locating the micrometer and stock of the combination square in the proper relation to each other. By using a 24-inch scale, the tool would be available for measurements from 1 to 18 inches. A tool of this kind can also be used for obtaining large inside measurements on flat work. For this purpose the micrometer and the stock *B* are reversed so that the dimension is obtained by placing the face of the stock against one side of the work and then unscrewing the thimble of the micrometer until it engages with the opposite side.

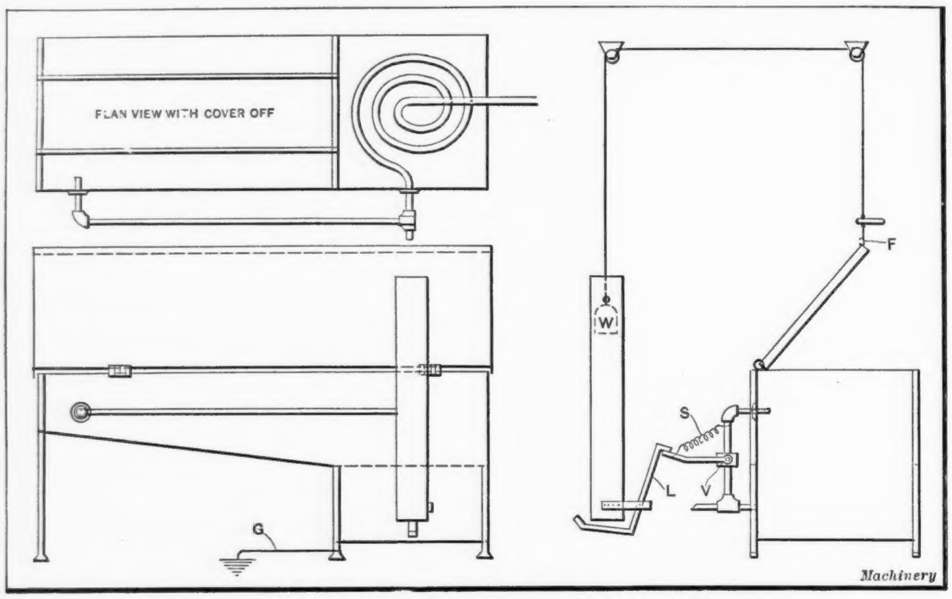
Cincinnati, Ohio HENRY FRANZ

A FIREPROOF JAPANNING TANK

The writer has had considerable experience with fires which occur in japanning-rooms due to spontaneous combustion, short circuits, and explosions of gas which rises from the japanning-tanks. In the following is described a fire which recently broke out in the japanning department of a metal working factory. In this department, where articles were being dipped in japan, the general arrangement and condition of the apparatus was nothing to brag about. It consisted of a tank 5 feet square with a rack located near it, on which the baskets of dipped material were placed to drain until it was time for them to be baked. The condition of the brick floor around this apparatus can easily be imagined, when it is known that japanning was carried on day and night. On the day of the fire, the operator had just placed a basket of loose articles on the dripping-rack. Suddenly there was a flash; the japan in the tank caught fire but instead of the flames spreading, they confined themselves to the open tank. The operator, with the use of sand, had the fire under control when the fire department arrived. Regardless of warnings not to turn on a stream, the firemen resorted to the use of a portable chemical extinguisher. As soon as the stream struck the burning japan in the tank there was an outburst of flame and the burning japan was spread over the floor, making a much more stubborn fire.

After the fire, the tanks and racks were inspected and found to be useless; then the writer designed the apparatus shown in the illustration, which not only "does the trick" but affords protection against disastrous fires. This apparatus consists of a galvanized iron tank 15 feet long by 4 feet wide, containing a dipping-tank and dripping-racks. The floor of the portion of the tank containing the dripping-racks is inclined toward the dipping-tank so that the drippings flow back into

the tank. In the bottom of the dipping-tank is placed a steam-coil which heats the japan, thus preventing it from settling. The pipe which feeds the steam-coil enters the side of the tank near one end. Another steam-pipe enters near the opposite end, and in case of a fire, this pipe turns a flow of steam into the tank which helps to smother the flames. The tank is



Japanning Tank with Provision for automatically extinguishing Fires

thoroughly connected to the ground by a No. 6 copper wire *G* which will carry off any static or frictional charges of electricity that may collect. A hinged lid covers the tank. The handle for raising and lowering the lid is attached to a wire-rope which runs over a sheave, and a fuse-link is placed in the wire rope where it is fastened to the lid of the tank.

Referring to the illustration, the weight *W* rides in a wooden case or runway, the lower end of which contains a latch controlling the lever valve *V* in the steam-pipe. When a fire occurs, the fuse-link *F* melts and allows the lid to drop. At the same time the weight *W* slides down the wooden case or runway and trips the latch *L*; the spring *S* then throws open the lever valve *V* and the steam rushes into the closed tank and smothers the fire which may still be smouldering, owing to the lid admitting some air. The tank is supported by legs at each end. The floor around the tank is covered with a thin coating of loose ashes, which catches any japan that happens to be spilled and allows it to be cleaned up without injury to the floor. Clean ashes may easily be substituted, thus keeping the working space around the tank dry. This apparatus not only makes the operator feel more secure but enables him to turn out more work and work of a better quality.

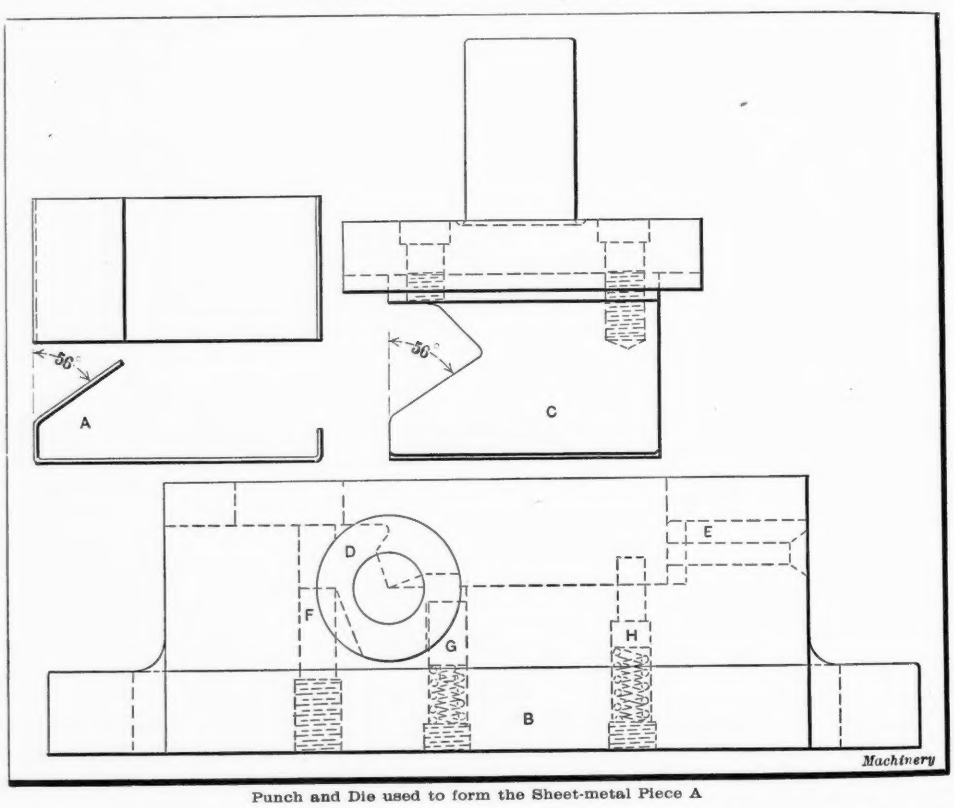
Worcester, Mass. A. P. Broadhead

PUNCH AND DIE FOR BENDING PAST THE VERTICAL LINE

The punch and die illustrated herewith were designed for bending sheet-metal parts to the form shown at *A*. In producing work of this kind, the first operation is to shear off blanks of the required length. The second operation consists of bending these blanks to shape in the die here described. The equipment consists of a cast-iron die-bed *B*, a punch *C* and a rocker-arm *D*. The blank is laid on top of the die and the punch descends to make the 90-degree bend at each end. The bend at one end is made between the the punch and the hardened steel block *E* on the die. The bend at the opposite end is made between the punch and the rocker-arm *D* on the die. The distance between the face of the block *E* and the nose of the rocker-arm is the exact length of the work on the outside.

The principle on which this punch and die operate in making the 56-degree bend is as follows: When the punch descends into the die, it strikes the lower part of the rocker-arm, causing the nose to move to the right and bend the blank over the inclined face of the punch. The movement of the rocker-arm to the right is equal, in amount, to the downward movement of the punch after engaging with the rocker. This causes the metal to be closed in on the side of the punch with the same degree of precision as if the bend were actually made between the punch and a fixed die.

The rocker is provided with ample backing to make it sufficiently rigid. There are two adjustable anvils *F* for the rocker-arm to fall back on, and two spring plungers *G* are situated at the opposite side to provide for the positive return of the rocker to the rear position when it is not engaged with



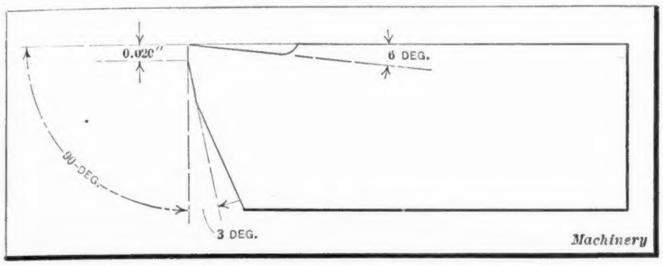
Punch and Die used to form the Sheet-metal Piece A

the punch. The punch is the exact shape of the formed piece, the latter being slipped off the punch by hand; a knockout could, of course, be provided to do this operation more rapidly if the quantity of work to be produced warranted it. A spring and plunger *H* are used to eject the stock from the die at the end opposite to the 56-degree bend. This was found necessary because there would be a tendency for the work to be pulled out of shape if some positive means were not provided to insure having it follow the punch out of the die. The punch is made ½ inch wider than the stock, the extra surface taking up the thrust incident to moving the rocker.

Toronto, Canada. E. Hawkins

A USEFUL LATHE TOOL

Mechanics who are called upon to use broad "sweep-facing" tools on cast iron, will appreciate the method of grinding outlined in the present article, because it will permit such tools to be used on many jobs where they would otherwise fail. While "boosting" production in a large gas engine factory, the writer had difficulty in sweep-facing flywheels 22 inches in diameter by 3-inch face. An old and badly worn turret lathe was used for this work, and after trying the tool with varying degrees of top rake and clearance—only to find that it would either chatter or refuse to cut in all cases—the writer was about to give up trying to use this style of tool. After letting the matter rest over Sunday, the idea was conceived of grinding the tool to the form shown in the illustration. The cutting edge was first produced with no clearance, and then a three-degree clearance was ground to a point within about 0.020 inch below the cutting edge. The result was highly successful. The tool cut freely and smoothly at a surface speed of 64 feet per minute. The writer has since applied



Method of grinding Sweep-facing Tools to eliminate Chatter

this principle in a number of cases, making the necessary modifications to meet the requirements of individual classes of work, and has found it a sure remedy for chatter. Try it, even where you feel that your tool is working satisfactorily, and you will be both surprised and pleased with the result.

Lansing, Mich. ARTHUR NICHOLS

MAKING SMALL ECCENTRICS IN THE LATHE

We had a "hurry call" for one hundred of the special eccentric pieces of the design indicated in Fig. 1. With the exception of the two diameters, the limit of tolerance was 0.007 inch which was decidedly in our favor; as a matter of fact, however, the pieces came far closer to the indicated dimension. A speed lathe with a three-jaw universal chuck was selected to do the work. A cut-off tool and a standard 60-degree circular forming tool were mounted on the hand-operated cross-slide, and a turning tool was put in the tool-

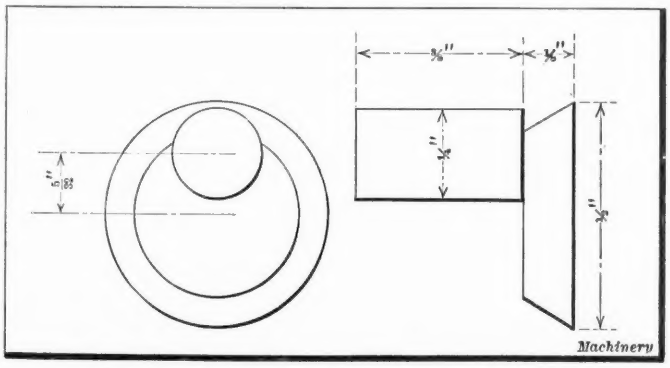


Fig. 1. One of the Eccentrics—Twice the Actual Size

holder carried in the tailstock spindle; this tool also acted as a stop against which the bar was fed. The plate at the end of each piece was concentric with the bar from which the work was turned and the one-quarter inch stem was turned eccentric, the distance from the center of stem to the center of bar being five-thirty-seconds inch. The eccentric stem was turned by employing a slip piece or clip, which was placed over one of the chuck jaws; this clip was of the proper thickness to give the desired eccentricity.

The operations were as follows: 1. Feed the bar to the stop; 2. turn the stem; 3. remove the clip from the chuck jaw and form the angular face of the plate; 4. cut off. The clip was then replaced on the chuck jaw, when the lathe was ready to have the bar fed out to the stop for a second series of operations. It will be observed that it was necessary to stop the machine after the production of each piece. This was not so serious a matter as it might seem, however, be-

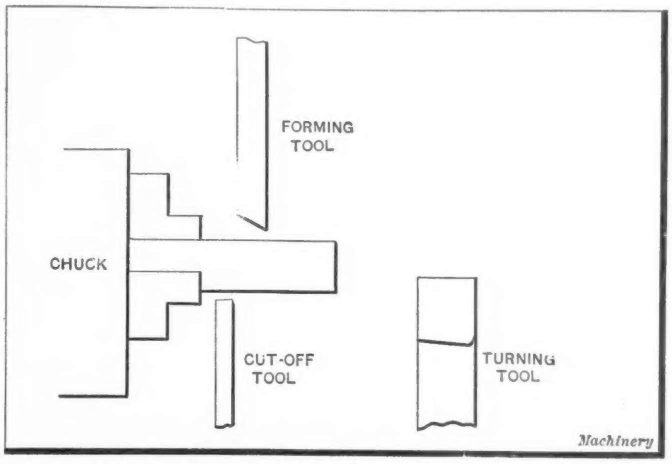


Fig. 2. Lathe and Tools used in turning the Eccentric

cause a foot-operated brake was employed to bring the spindle to a standstill as rapidly as possible. This work was finished from cold-rolled steel bars, and very good time was made in producing the one hundred pieces that were called for in our order. There was practically no expense involved for tool making.

Middletown, N. Y. DONALD A. HAMPSON

COMPARATIVE CHIP PRODUCTION OF STELLITE AND STEEL TOOLS

Machine tool builders are at the present time more deeply interested in rapid metal cutting than ever before, and it is generally assumed that we now have our most modern machine tools of sufficient capacity to get the maximum in speeds and feeds from high-speed steel. Some of our most modern machines are supplied with sufficient tool pressure combined with high enough speeds to break down the best grades of high-speed steels produced.

The description of "Stellite," as presented by Mr. Haynes in the February number, is of much interest, but while Mr. Haynes gives us some very interesting accounts of the speeds at which it is possible to run when using this alloy known as "Stellite," it is rather surprising to note that the amount of metal removed per minute is so small.

With ordinary carbon tool steel it is possible to remove more than 2.4 pounds per minute, and with the best grades of high-speed steel we all do many times this. The speed attained by the use of "Stellite" seems very high, but if it were possible to combine this with metal-removing capacity it would be of greater value. Ordinary abrasives can cut at the rate of over 5000 feet per minute, but it has not yet been demonstrated that their metal-removing capacity will equal a cutting tool.

On a recent test of a Lodge & Shipley heavy forge lathe we removed from an 8-inch 0.60 carbon shaft chips at the rate of 20,000 pounds per day of ten hours run. This 20,000 pounds divided by the 600 minutes constituting the ten-hour day would equal 33 1/3 pounds per minute. As a matter of fact we can do better than this and have done better on short runs, and the principal reason for not making longer trials was the unnecessary waste of good material. We can guarantee our heavy forge lathe to remove its own weight in a day's run of ten hours.

It would be interesting to learn just what can be done with this alloy "Stellite" as a metal remover, leaving out the question of high-speed cuts of small chip. Possibly by this time Mr. Haynes has made more extensive experiments and can give us some further data. WILLIAM SCHELLENBACH

Cincinnati, Ohio.

DISTRIBUTION OF CATALOGUES

It was with much interest that I read the letter by Yamatake & Co. in the January number on catalogue distribution in Japan, and with much more interest the editorial comment with regard to the distribution of such matter.

It is generally believed among the trade I think, that the columns of trade papers are dominated by the manufacturers or agents. Yet here the editor takes a stand for the young man and machinist that is to be highly commended, as the practice of giving away catalogues to such is considered as expense without return by many firms in this country who only follow the custom because it is forced on them by more far-sighted concerns.

It has always been a plan of the writer to anticipate the probability of having to work on a machine or special tool, the details of which would likely give trouble, by writing and asking the manufacturer for a catalogue stating the purpose for which it was to be used, and such requests have never been refused. I consider the manufacturers benefited by my interest, yet I am sure there are many others who would join with me in thanking them for their liberality in such matters.

It is a fact that the executive positions of to-day will only too soon be held by a younger generation and such favors will not be lost sight of. A manufacturer like Yamatake & Co. does not hesitate to furnish any firm with such catalogues as they request, yet from my observation of the general use made of such literature, I question whether the distributors receive any more direct advantage than they do in giving them to an interested public.

The writer wishes to praise the public stand the editor has assumed in a matter that might have been settled in a private way. It promotes a better understanding between the reader and advertiser and shows our distant neighbor the liberal spirit that prevails here in regard to such matters.

Brooklyn, N. Y. JOHN F. WINCHESTER

ERASING ON TRACINGS

While the writer feels that more space has now been allotted to the subject of erasing on tracings than his brief remarks in the September issue warranted, he takes the liberty of offering his ideas relative to the arguments set forth by Mr. A. H. Myers in the November issue, and by Mr. Clyde L. Adams in the January issue, trusting that they may prove of further general interest.

Regarding the first mentioned suggestion, namely, the employment of a pencil eraser, the writer concurs, as far as such an eraser is applicable and permissible, which is not by any means *always*. Mr. Myers himself explains this by suggesting the use of both ink and pencil erasers at times. Furthermore, the writer is of the opinion that the use of a pencil eraser will be found to have a greater tendency to discolor the cloth than would the proper handling of an ink eraser, on account of the excessive amount of rubbing that is needed.

Apropos of Mr. Adams' remarks, the writer fails to see their exact significance as applied to a mechanical drawing of regular nature. With a single line or word on a tracing, or in particular instances on a regular drawing, the smearing of ink over the cloth may make it easier to remove, but it seems quite evident that one cannot always, or even frequently, smear the ink without spreading it into some other finished part of a drawing. Thus it would hardly appear concordant to necessitate the erasure of a section or portion of a completed view or part of a notation, letters or figures as the case may be, simply because of a slight error in drawing or marking.

Even though the smearing might accomplish an easier eradication, and this the writer does not find, himself, it would naturally follow that a line is more easily erased without being noticeable, than a square inch or more of surface would be. Regardless of how heavy the line or lines on a drawing may be, the writer has found, through a considerable period of experience, that the correct and careful handling of an ink eraser in connection with an erasing shield when one is necessary, as noted in his original letter in the September issue of MACHINERY, is the easiest, simplest, quickest and most practical method.

Newark, N. J. L. R. W. ALLISON

HARDENING SMALL PUNCHES WITHOUT DISTORTION

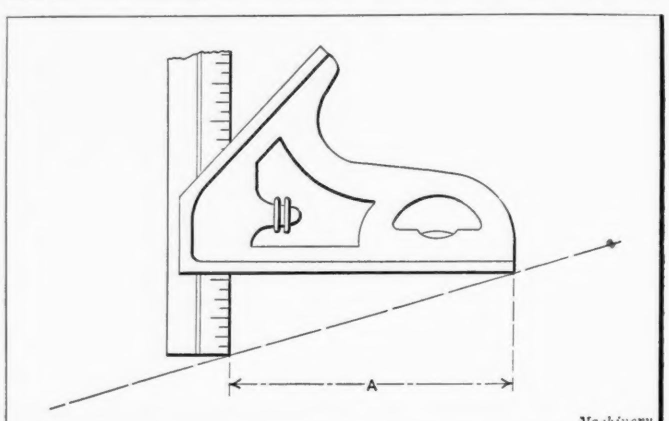
The article in the January issue of MACHINERY, by M. H. P. A., describing and illustrating a method of straightening small punches after hardening, recalls a method originated and used by the writer for hardening small punches or drills made of straight wire to a degree of perfection which obviates the necessity of straightening. The process consists of rolling the wire, when at the proper heat for hardening, between two flat surfaces, such as a bench plate and a parallel from 2 to 4 inches wide. The operator arranges a bunsen burner as close as possible to the bench block and takes the parallel in the right hand and the wire to be hardened in the left. The wire is left long enough to handle, so that the end to be hardened can be passed back and forth through the flame. When the proper heat has been obtained, the hot end of the wire is quickly placed on about the middle of the bench block, and rolled back and forth with the parallel. If one will take the pains to do this deftly, the result will be surprising, the wire being perfectly hard and straight. Wire up to 1/8 inch in diameter can be hardened in this way, but for wire from 1/8 down to 3/32 inch in diameter it is a help to smear the block with a thin coating of heavy oil or tallow, which assists materially in dissipating the heat.

Springfield, Mass. E. E. NEAL

SETTING UP WORK AT AN ANGLE

In the January number of MACHINERY there was an article on the use of a carpenter's level for setting up work at an angle on a drill press or planer. While this method does not require very much work, every machinist has in his possession a combination square which, without any alteration, can be used for the same purpose with, perhaps, a greater degree of accuracy.

In a 12-inch square, the distance A varies with the different makes. For example, we wish to set the work at 14 degrees,



Use of Combination Square to set up Work at any Required Angle

30 minutes, and the distance A is 3 5/8 inches. The tangent of 14 degrees, 30 minutes is 0.25862; then $3.625 \times 0.25862 = 0.93749 = 15/16$ inch. Then by setting the scale 15/16 inch below the head, it will give you the required angle. If the work is large and rough, an additional scale or straightedge may be placed between the combination head and the work.

O. T. R.

WINDING A CONICAL SPRING

Instead of winding a conical spring on a tapered arbor grooved to the proper pitch, which is the usual method, I find the following one more advantageous. A cone arbor, preferably one fitted to the lathe spindle like a center, has a slot cut across its nose to accommodate two wires which are wound over the arbor together, much as a boy might wind two strings on his top at once. If a more open spring is desired, three wires might be wound simultaneously, making three springs at a time.

Norwich, Conn. GEORGE W. ARMSTRONG

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

RIVETT NO. 6 INTERNAL GRINDER

The illustrations show front and back views of the improved design of Rivett No. 6 internal grinder which has been on the market by the Rivett Lathe & Grinder Co. (Brighton District), Boston, Mass. This machine is particularly designed for internal grinding, and its accuracy makes it especially adapted for tool-room work. Special fixtures have been provided for the machine, however, which equip it for external grinding on work that can be taken between centers, having a maximum distance of 17¾ inches. The base of the machine is a one-piece casting and is designed to hold the driving gears and the reciprocating mechanism used in operating the table. Referring to the front view of the machine, shown in Fig. 1, the change-gear speed box will be seen located on the left-hand side of the column, and the hinged door at the center of the machine gives access to the driving gears and reciprocating mechanism.

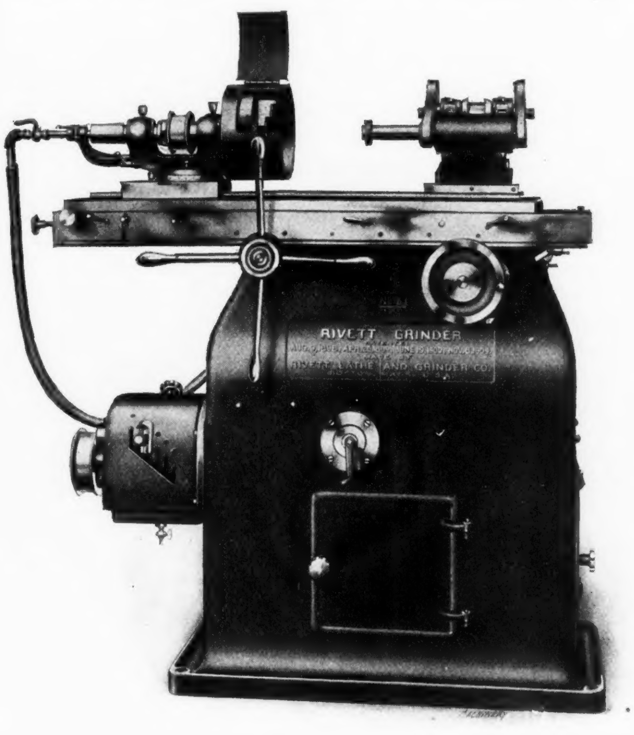


Fig. 1. Front View of Machine showing Gear-box and Operating Levers

The table of the machine is in two sections. The lower section is mounted on the base and slides on broad bearing surfaces, its movement by power being controlled by a reciprocating mechanism which is so designed that as the center of the stroke is approached, the speed of the table is slightly retarded; the speed is similarly accelerated after the central point of the stroke is passed. This speed variation eliminates the tendency of the wheel to take a lighter cut at the center of the work, and at the same time allows a coarser feed to be used. A small handle will be seen near the center of the table which allows the reciprocating mechanism to be disconnected and the table stopped at any time without stopping the machine. The stroke can be varied by thousandths of an inch by turning the crank shown immediately above the door in the column, the maximum stroke being six inches. Six different speeds of table travel are obtained through the gear-box at the left-hand side of the machine; these changes of speed are quickly made by regulating the position of the handle on the gear-box. Another interesting feature of the table design is the provision of a stop which enables the table to be brought forward to the same position which it occupied before releasing the reciprocating mechanism and backing the table away to gage a hole. This insures having the wheel cut to precisely the same depth as before the table and reciprocating mechanism were disconnected. Referring to Fig. 1, the knurled knob on the stop will be seen at the left-hand end of the table; this stop is clamped in any required position by the small handle which is shown near it at the front of the table. The upper section of the table is arranged to swivel five degrees in either direction from the center and is adjusted by screws at the front and back of the table; these screws will be seen in Figs. 1 and 2, closed to the table stop previously referred to. The slide is clamped to the table by turning the small clamp handles, one of which is shown next to the adjusting screw in the front view of the machine, and the other at the opposite end of the table in the same illustration. The table is quickly controlled by hand by means of the pilot wheel at the front of the machine.

Referring to the rear view of the machine shown in Fig. 2, a good idea of the design of the cross-slide will be obtained. The base on which this slide rests is graduated and the slide can be set at any angle up to 90 degrees in either direction from the central position, and clamped by means of a binding nut. The maximum cross-travel is 3½ inches and may be controlled by hand through the use of the wheel seen at the right-hand side of the front of the machine. When power feed is required, the button at the center of this wheel is pulled out and the feed is regulated through two small clamps shown beneath the table at the right-hand side. Variations of feed are obtained by means of a ratchet wheel located directly behind the wheel used in controlling the cross-feed by hand.

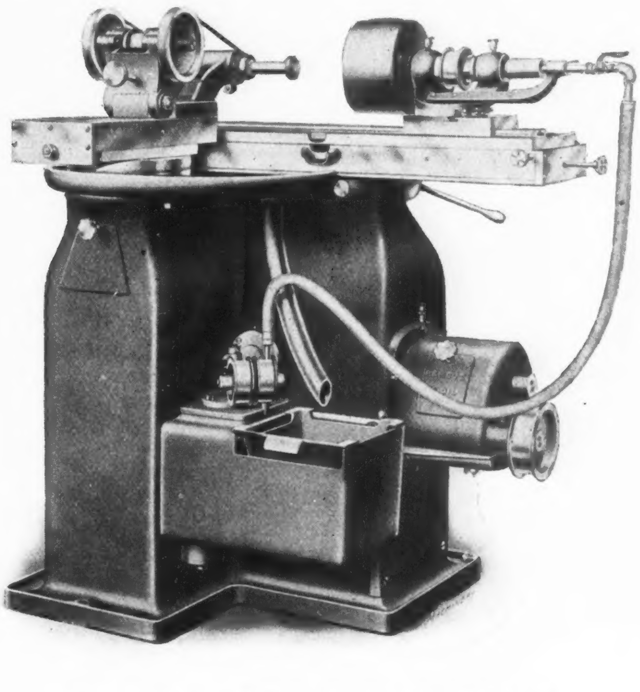


Fig. 2. Rear View of Machine showing Cross-slide, Pump and Water Tank

The work head is mounted on a cast-iron plate fitted to the slide, and can be moved any required distance along the slide and clamped in position through the medium of an eccentric lever. It is locked in the neutral position by means of a taper pin. The spindle is made of high-carbon tool steel, hardened and ground, and runs in tool-steel tapered bearings which are also hardened and ground. This form of construction has been found especially suitable for the class of service required of this machine. The high speed at which machines of this type are operated, makes it imperative to have bearings which fit perfectly, and quick means for adjusting the bearings have been provided. The front end of

the spindle is ground on the inside to hold split chucks and the rear end is made to fit the draw-in spindle furnished with the machine. The spindle is driven by a cast-iron pulley from a drum on the overhead countershaft and three spindle speeds of 1340, 656 and 189 R. P. M. are provided.

The grinding wheel spindle is also designed for operating at high speed and is fitted with the Rivett ball and cone type of bearing enclosed in a cast-iron shell. Adjustment is made by loosening two set-screws at one end and turning the adjusting screw to the right to tighten, or to the left to loosen the bearing by means of a spanner fitting into two holes. When the proper adjustment has been obtained, there should be no shake and the spindle should run freely when twirled between the fingers. The wheel spindles can be quickly changed in the wheel bracket by loosening two thumb screws and the belt tightening screw, after which the spindle can be drawn out at either end. Each of the different spindles is fitted with suitable sized pulleys to provide the required speed. The wheel spindle bracket is made in two sections. The forward section holds the wheel spindle and the rear section is designed to hole the countershaft for driving the spindle. This section may be adjusted by a screw to give the required belt tension. This method of adjusting the belt tension also makes it possible to use an endless belt, which is more satisfactory than a joined belt, where high speeds are required. The bearing caps can be quickly loosened and turned back to remove the countershaft by simply removing two screws. The countershaft is driven by the central pulley and runs in taper bronze bushings, the shaft being of hardened and ground tool steel and provided with means of making rapid adjustments for wear. The driving pulleys are six inches in diameter and flanged on both sides to take a belt ¾ inch wide; three speeds are obtainable through a three-step cone pulley on the overhead countershaft. The overhead countershaft is self-contained, all brackets, shafts and pulleys being assembled on a cast-iron base. This greatly facilitates setting up, insures the proper alignment of the shafts in their bearings and also materially reduces the power necessary to drive the machine The countershaft is designed to operate at 500 R. P. M.

The water tank and pump are shown at the rear of the machine in Fig. 2. The pump is driven by pulleys from an overhead countershaft and the necessary piping attachments are furnished for both internal and external grinding. The flow of water is controlled by a valve placed within easy reach of the operating position. The illustrations show a water guard surrounding the chuck for internal grinding; a guard for external grinding operations can also be provided.

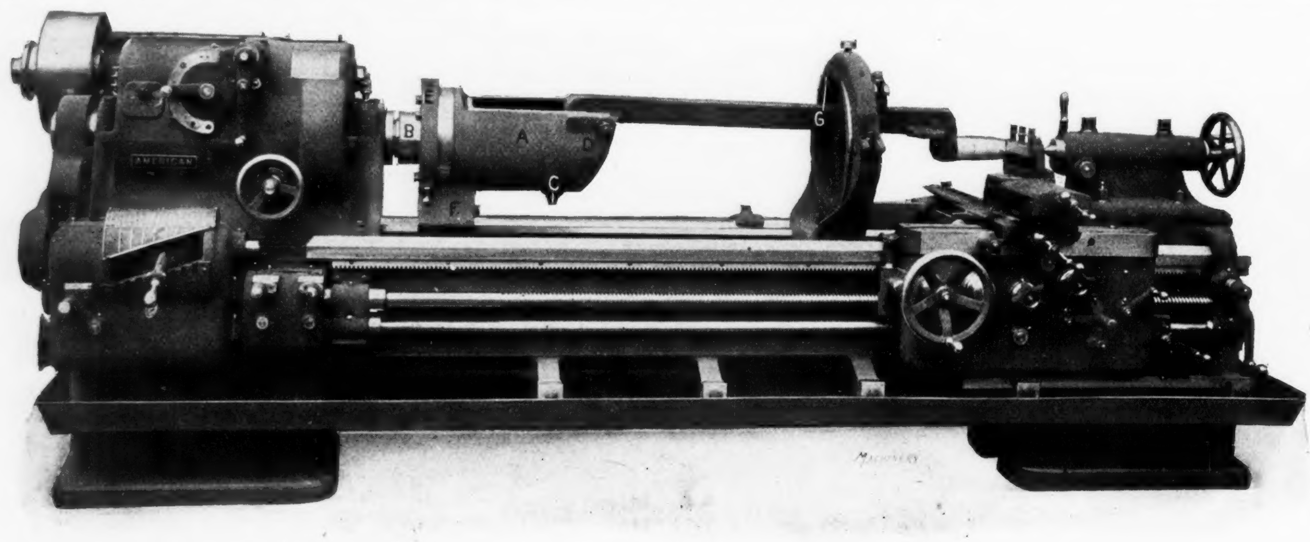


Fig. 1. American High-duty Lathe equipped with Special Fixture for turning Axles after being formed to Shape

AMERICAN HIGH-DUTY AXLE LATHE

The accompanying illustrations show the new American high-duty axle turning lathe designed and built by the American Tool Works Co., of Cincinnati, Ohio, for the express purpose of machining motor truck axles. The old method of doing this work was obviously unsatisfactory, for the machining had to be done while the axle was straight, after which the forming or shaping was accomplished by means of a die, and this produced inaccuracies in the work. The new method, however, permits the machining of the axle after it has been formed to the required

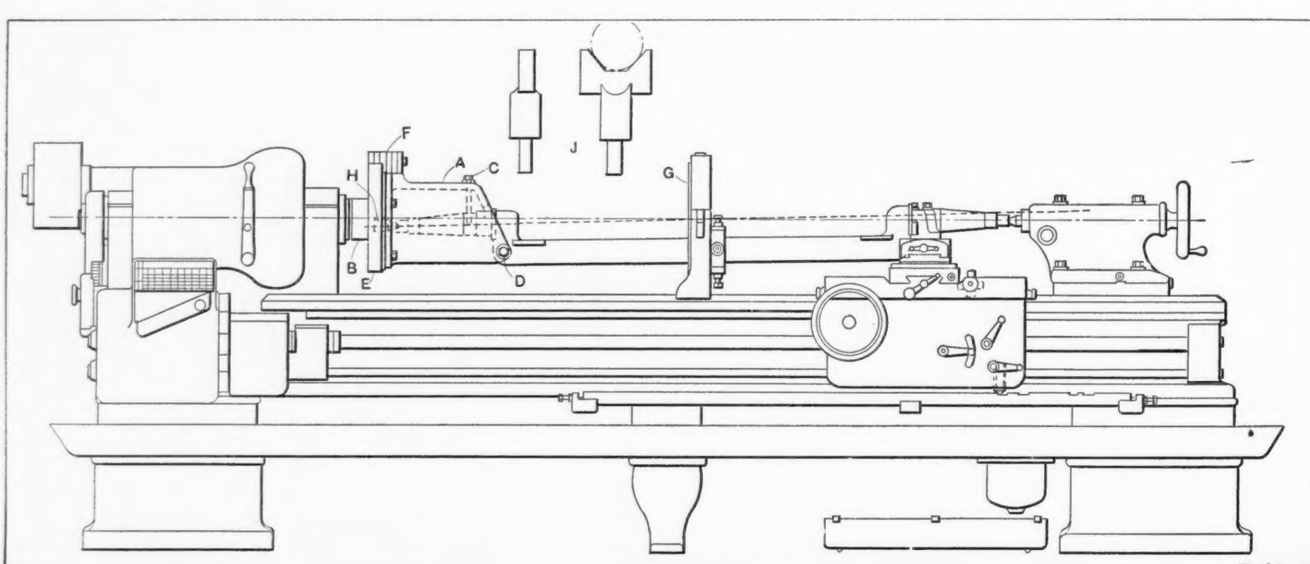


Fig. 2. Axle Turning Lathe, showing Fixture for Axle Turning and Detail of V-block J

shape, and therefore completely eliminates the distortion of the work produced by the old method. The following description will be confined prinicipally to the fixtures which have been designed especially for handling this work.

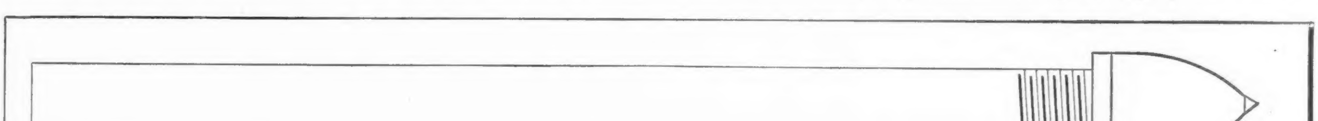
The distinguishing and most important feature of this machine is the eccentric chuck *A*, which is held by heavy bolts to a removable plate *B* screwed onto the spindle nose. This chuck, which is made from a steel casting, locates the work to bring the axle bearing in line to be turned. The action of the chuck is very similar to that of the universal chuck used on crankshaft lathes for bringing the crank throws into position for turning. The rough axle is suspended between centers, the chuck-center *H* being placed at the proper angle to throw the end which is to be turned, into position. After the axle has been placed between centers, the adjustable V-block *J*, shown in detail in Fig. 2, is adjusted by means of nut *C* until it holds the axle firmly in position. One of the advantages of this V-block is that it automatically centers the axle and eliminates all tendency for the work to twist. The screws *D*, one bearing on either side of the axle, act as drivers, and are adjusted after the axle has been properly located. Fastened to the band *E* is a counterweight *F*, which is supplied to offset the weight of the eccentric axle.

A rotary steadyrest of steel construction is furnished for steadying the work. The axle is held in the rotor *G* which rotates inside of a steel casing lined with a removable castiron ring. This ring is so constructed that in case of wear it can be readily replaced by a new one without any detrimental effect to the rest proper. Efficient means for lubricating this rest are provided, including compression grease cups and babbit and graphite inserts. Longitudinal and diametral stops are supplied for the different turning and shoulder facing operations, and the regular taper attachment used on the lathes built by the American Took Works Co. has been found entirely satisfactory for turning the taper on the ends of the axle. Aside from these features, there is nothing special in the design of this lathe, it being of the well known American high-duty type.

STRONG DIAMOND HOLDER

The illustration shows the Strong diamond holder which has recently been placed upon the market by Montgomery & Co., 105-107 Fulton St., New York City. This tool is designed for use in dressing emery wheels and a cut diamond is used which is shaped with six points, all of which are available for cutting.

Referring to the cross-sectional view of the tool, it will be seen that the diamond *A* is held in the shank *B* by means of the threaded cap *C* and copper plug *D*. When the cap is screwed up, the diamond is securely held between the cap and copper plug by the tension of the spring *E*. This design has two important advantages; first, the diamond cannot work out of the tool as long as the cap *C* is left in its original condition; and, second, the diamond can be placed in the tool in any position to bring either of its six points into position for cutting. This adds greatly to the wear of the diamond. The possibility of breaking the diamond is also materially reduced as it cannot be clamped too tight or forced too hard against the work on account of the tension of spring *E*, which will automatically relieve the pressure from the diamond.

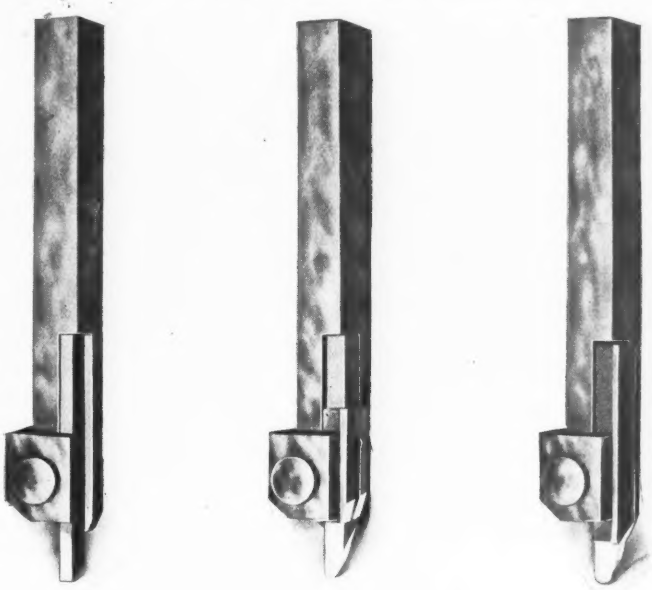


The Strong Diamond Holder for use in dressing Emery Wheels

CARR PLANER TOOLS

The Carr planer tools illustrated herewith, are a recent product of Henry G. Thompson & Son Co., New Haven, Conn. By referring to the illustration, it will be seen that the tools consist of a holder in which a cutter of high-speed steel is mounted. The holder consists of three parts: the shank, cap and bolt. The socket formed between the holder and cap is dovetail in shape and the side of the cutter is ground to fit into this socket.

The tool shown at the extreme left of the illustration has a cutter mounted in it which is made of narrow stock, and in



Carr Planer Tools fitted with Different Styles of Cutters

this case the cutter is not ground dovetail, the shoulder on the cap fitting over the edge of the cutter. In the tool shown at the center of the illustration, the cutter is also made from narrow stock, but in this case an adapter is used to clamp the cutter in the holder; in this tool, it will also be seen that the cutter has been ground away considerably and that an auxiliary block is placed above the cutter to back up the tool. The tool shown at the right-hand side of the illustration is fitted with a cutter of the regular size, and the description given at the beginning of this article applies to this tool.

These tool-holders are made in six different sizes, ranging from 5/8 by 1 1/4 by 8 1/2 inches to 2 1/8 by 2 3/4 by 22 inches, as the size of the shank. The tools are made either right- or left-hand, as desired, and it will be evident that the cutters can be ground at both ends so that they are adapted for use in either right- or left-hand tools.

STANDARD BACK-GEARED POWER PRESS

The illustrations show front and back views of the No. 6-B back-geared power press which has recently been placed on the market by the Standard Machinery Co., 7 Beverly Place, Providence, R. I. The design of this machine enables power to be transmitted either direct or through the back-gears. In Fig. 1 the machine is shown from the balance wheel side, where it will be seen that there is an adjustable knockout

which is actuated by an eccentric rod connected to the slotted disk at the end of the crankshaft. This knockout is used for forcing out swaged material from below and is made adjustable on the crankshaft end. In addition to this, a second knockout has been provided for ram of the press, which is actuated from the special knee put on the frame at the rear; this knockout operates through the slotted hole in the rear of the ram.

Fig. 2 shows a rear view of the press, where the pinion at the extreme end of the shaft is seen to be out of mesh with the driving gear. This is the location of the pinion when the machine is being driven direct through the tight and loose pulleys. An adjustable collar slides along the shaft and is used to retain the pinion in mesh with the gear after pushing it back for the purpose of driving the press through the balance wheel. This machine is designed for blanking, swaging and forming operations and is particularly suitable for use in cases where a quick stroke is required. The instantaneous roller friction clutch used on the machines built by this company has been applied in the design of this press, the diameter of the ring fitting into the driving gear which is 13½ inches. The crankshaft is of forged nickel steel and is of liberal dimensions; the diameter of the wrist pin is 5¼ inches, the bearing being 8 inches long. The driving gear is of gun iron and is 42 inches in diameter; it has an extended hub on which the tight pulley is keyed, and the loose pulley runs on the crankshaft which is turned to four inches in diameter at the end. The pinion is made from a steel forging.

The upper connection is of iron and the lower or ball connection of froged steel, threaded into the upper and provided

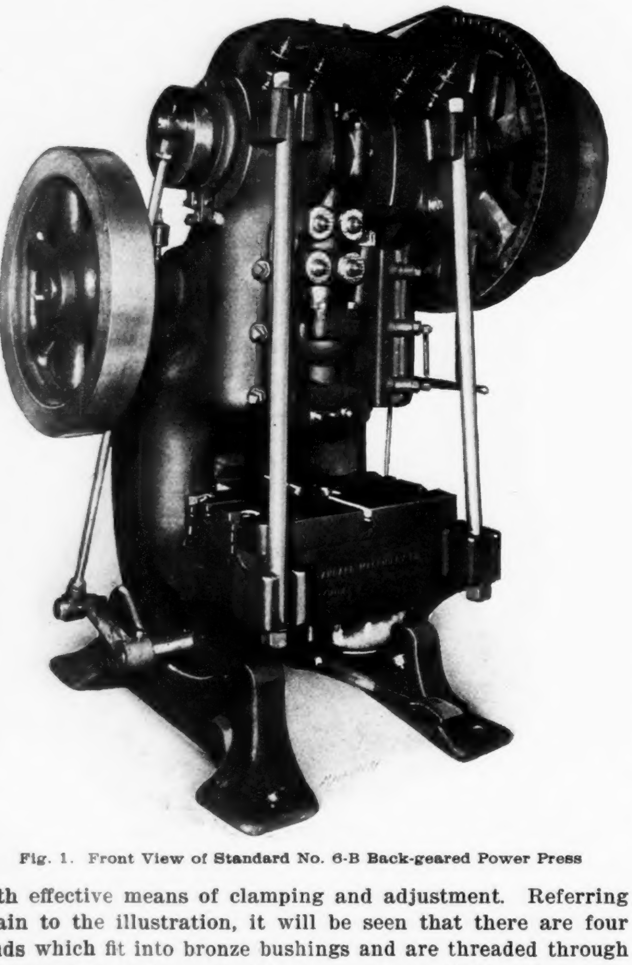


Fig. 1. Front View of Standard No. 6-B Back-geared Power Press

with effective means of clamping and adjustment. Referring again to the illustration, it will be seen that there are four studs which fit into bronze bushings and are threaded through the rear side of the connection. In order to tighten the upper connection after adjustment, these studs are turned, forcing the bronze bushings against the thread in the steel lower connection. The bottoms of these bronze bushings are threaded at the same time the thread is tapped in the upper connection, thereby having thread fit thread and avoiding bruising the shank of the lower connection. The ball is scraped into the ram and retained by a large bronze shoe. The ram is fitted with a three-inch hole through which the knockout operates, as previously mentioned. For swaging and forming, the machine is generally used with heavy tie-rods, and when large sheets are being blanked, the tie-rods can be removed. The press is designed so that these tie-rods extend from the upper bearing to the outer part of the bed on an angle, so that the maximum working space for the operator is obtained. The press is of the inclinable type and is built with the path of the ram directly below the bearings; this is one of the most important features of the press when it is to be used for swaging or forming, as well as for heavy blanking. The machine is built with the Standard type of brake on the crank-

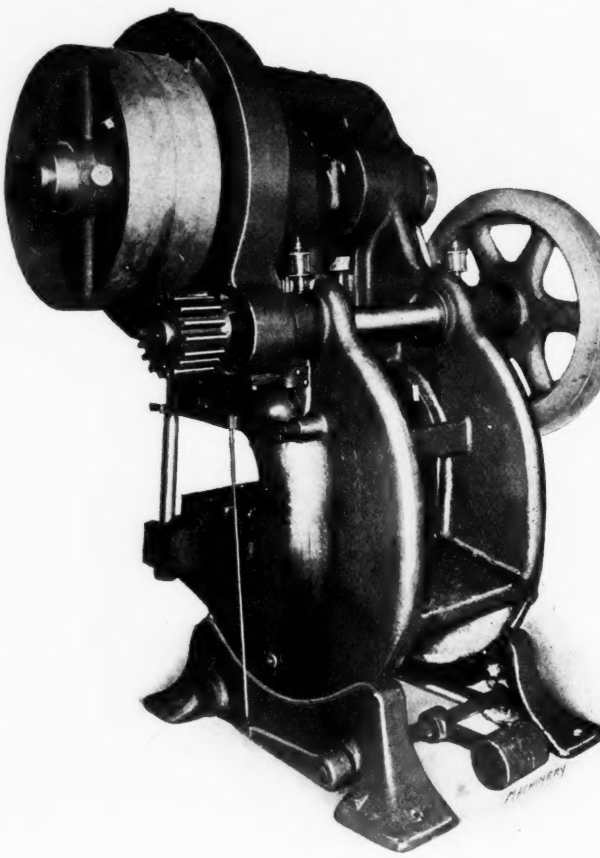


Fig. 2. Rear View of the Press with Back-gears out of Mesh

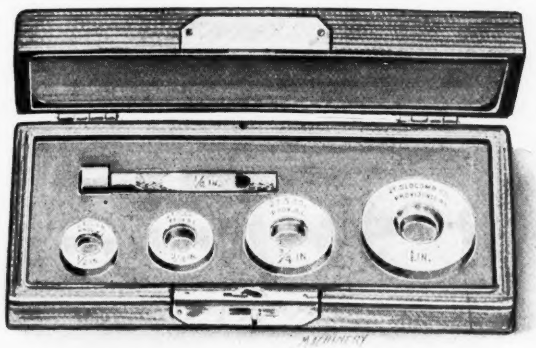
shaft. The bed has a thickness of 9 inches below the bolster plate and in addition to the regular 9-inch bolster, 3½- and 4-inch bolsters can be used. The weight of the press is 14,800 pounds and it occupies a floor space of 6 feet by 5 feet 6 inches.

SLOCOMB DISKS FOR TESTING MICROMETERS

Some purchasers of micrometers have never really considered that it was necessary to test these tools. While there is very little doubt regarding the accuracy of tools made by reputable manufacturers, it is an excellent plan for users of micrometers to have some means of properly testing them at specified intervals. After constant use a micrometer shows some wear and unless this wear is overcome by adjustment, one naturally is not going to get the correct measurements when using the instrument. Where it is customary to test micrometers, it will be found that, in the case of the 1-inch size, the usual method is to run the screw down until the point engages with the anvil and note whether the reading is correct, then run it out to the 1-inch limit, testing it with a 1-inch gage. This, of course, is one way, but there are those who feel that they want to be more particular, and they test the micrometer at 0.250, 0.500, 0.750 and 1.000 inch. This gives a more accurate test throughout the travel of the screw. This method is good, so far as it goes, but it leaves one feature of the micrometer that is particularly important, untested. It is necessary for the travel of the screw to be accurate, and also for the face of the anvil and the face of the screw to be parallel and perpendicular to the axis of the thread. It will be noted that by testing the screw at the

four points mentioned above, the thimble and screw would be in the same relative position to the anvil in each case, the opening between the anvil and the screw merely being increased.

In order to make the test properly, the micrometer screw should be turned half way around and tested at that point, which would give the result that was omitted in the first test. By turning the screws half way around it tests the travel of the screw and shows that the face of the anvil and



Disks used for testing the Accuracy of Micrometers

screw are parallel as well as perpendicular to the axis of the thread. The J. T. Slocomb Co., Providence, R. I., is just putting on the market a set of reference disks containing sizes 1/4, 1/2, 9/16, 3/4 and 1 inch, by means of which a 1-inch micrometer may be accurately and properly tested. This set is known as the No. 80 reference disks and should b of value in enabling tool and inspection departments to have their micromters periodically examined and tested for accuracy.

REED BENCH AND COLUMN DRILLS

The illustrations show improved types of bench and column drills which have recently been placed upon the market by the Francis G. Reed Co., 43 Hammond St., Worcester, Mass. These machines are constructed along the same general lines as the preceding types of bench and column drills

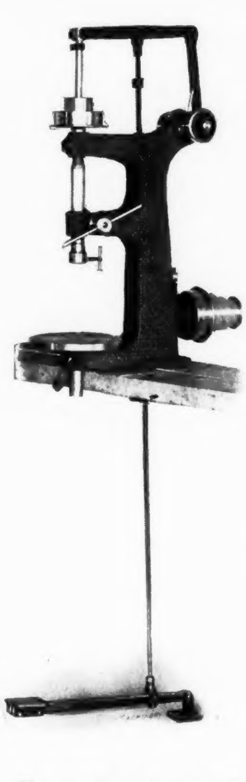


Fig. 1. No. 27 Bench Drill equipped with Lever and Treadle Feed

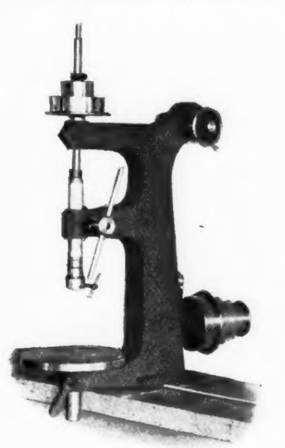


Fig. 2. No. 26 Bench Drill equipped with Lever Feed

Fig. 3. No. 28 Column Drill equipped with Lever Feed

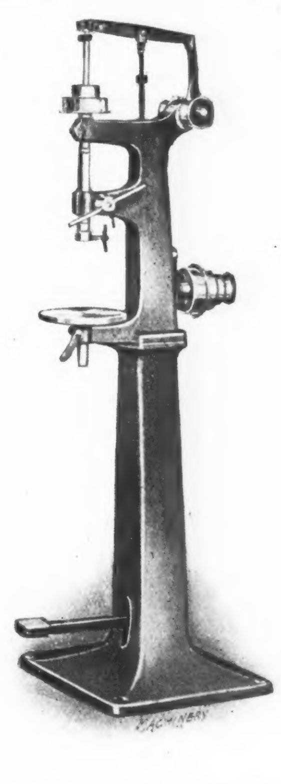
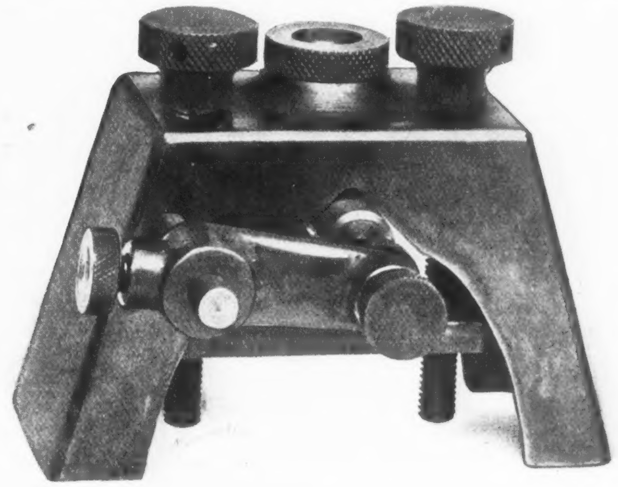


Fig. 4. No. 29. Column Drill equipped with Lever and Treadle Feed

manufactured by this company, but they embody the following improvements. It will be seen that the frames of the new machines are of the box type, while the preceding designs had round columns. The cone pulley at the back of the machine is attached in such a way that it can be adjusted vertically to regulate the belt tension. It will also be seen that the new design of drill is provided with six spindle speeds.

In the old style of drills, babbitt bearings were used to line up the table and pindle stud, but in the machines shown in the accompanying illustrations, the bearings are bored to secure the required alignment and no babbitt is used. In ma-



Hill Drill Jig for locating Drilled Holes at Center of Round Work

chines of both the bench and column type, equipped with lever-feed, ball-bearing thrust collars are used under the quill; and in the machines provided with both lever, and treadle-feed, ball-bearings are used under the quill and at the top of the swivel. The spindle has a bearing for the entire length of the quill and is turned at the end to fit all standard chucks. A two-jaw chuck and a complete countershaft forms part of the regular equipment.

HILL DRILL JIG

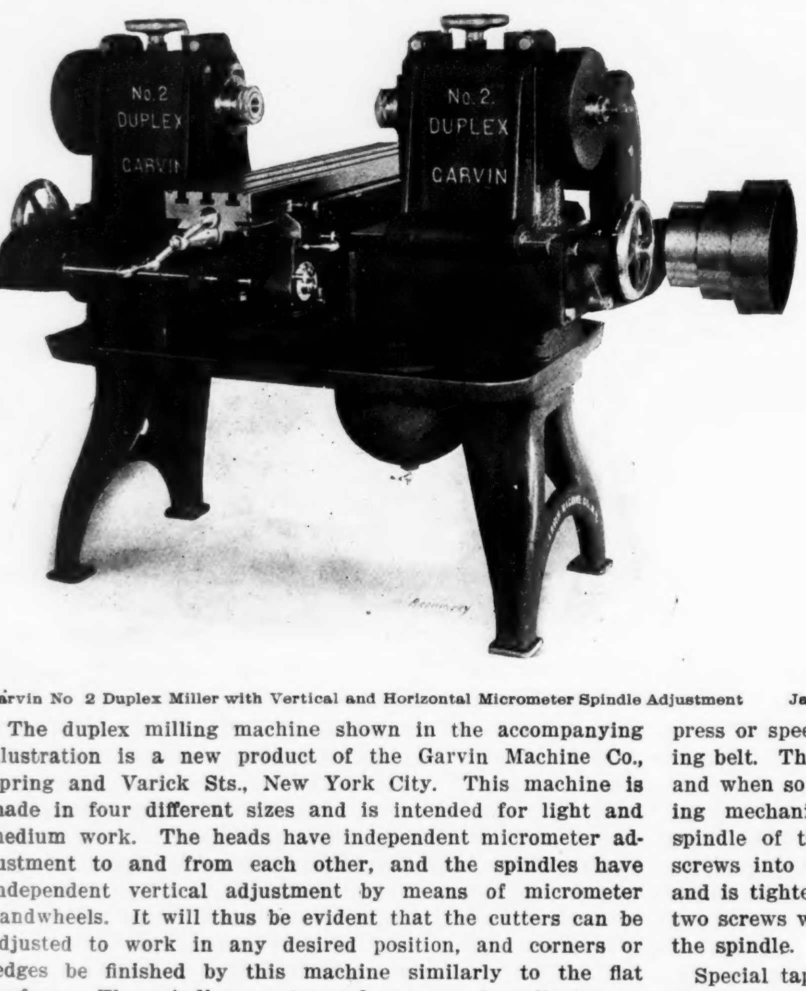
The drill jig shown in the above illustration has been designed and placed upon the market by M. T. Hill Mfg. Co., Worcester, Mass. This jig is intended for drilling round work, and its use enables a hole to be drilled within a limit of 0.002 inch of central. Taper pieces can also be drilled and

a hole can be drilled close up to a shoulder in a piece of work having two different diameters.

This jig is made in two sizes. The No. 1 jig will take work from ½ inch to 2 inches in size and weighs six pounds. The No. 2 jig will take work from 3/16 inch to 1¼ inch in size, and weighs 1½ pounds. An adjustable stop gage is provided to set the jig for the distance that is required between holes or for the distance between the hole and the end of the work. Standard size slip bushings from 1/4 inch to 1/2 inch in size, varying by sixteenths, are provided for use with this jig; and the same set of bushings will fit both the No. 1 and No. 2 sizes.

GARVIN NO. 2 DUPLEX MILLING MACHINE

The duplex type of milling machine has been developed for use in manufacturing operations which require two sides of a piece to be milled parallel. Machines of this type are particularly adapted for such operations, as they can be worked with speed and accuracy and the perfection of the work is not dependent upon the care and skill used by the mechanic in resetting the work to mill the second surface. As the two surfaces can be milled at the same time, and a second setting of the work is entirely avoided, it will be evident that a great increase of production is obtained.



Garvin No 2 Duplex Miller with Vertical and Horizontal Micrometer Spindle Adjustment

The duplex milling machine shown in the accompanying illustration is a new product of the Garvin Machine Co., Spring and Varick Sts., New York City. This machine is made in four different sizes and is intended for light and medium work. The heads have independent micrometer adjustment to and from each other, and the spindles have independent vertical adjustment by means of micrometer handwheels. It will thus be evident that the cutters can be adjusted to work in any desired position, and corners or ledges be finished by this machine similarly to the flat surfaces. The spindles are tapered and run in solid bronze boxes of the standard design adopted by this company. The drive is transmitted through a train of gears from the driving shaft, which runs along the rear side of the bed. Changes of speed are provided by the cone pulley on the driving shaft which is back-geared 3 to 1. The feed is obtained from the driving shaft by a series of change gears at the left-hand end of the bed; all of these gears are covered and handled from below, giving twelve changes of feed ranging from 1/200 to 1/8 inch, per spindle revolution. The feed-screw is driven direct by a hardened steel worm-wheel and tool-steel worm running in oil.

The table is fitted with an automatic trip and reverse at the right-hand side, and has a quick movement of one inch per turn of the screw, which is operated by a ball-crank. The oil pump and reservoir provide lubrication and extensions are provided to catch the oil dripping from the table. All of the gears are covered and the total weight of the machine is 2465 pounds.

THE JARVIS BALL-DRIVE TAPPING DEVICE

The most important features of the Jarvis ball-drive tapping device, made by the Charles L. Jarvis Co., Gildersleeve, Conn., are the ball-drive, which is used and the application of this drive at a point close to the work. This design adds to the rigidity of the tool without reducing its sensitiveness in any way. The illustration shows the device in position for the tapping operation, and when in this position, the tap is driven at the speed of the drill-press spindle, the drive being transmitted by means of three balls which engage with lugs in the body of the device. When it is desired to reverse the direction of rotation to back out the tap, the spindle of the drill-press is raised. This engages the quick return gears which back the tap out at a higher speed. The drive, in this case, is effected by means of two balls which engages with the stationary gear.

The tapping device can be operated in either a horizontal or vertical position so that it may be used on either a drill-press or speed lathe without the necessity of using a reversing belt. The taper shank screws into the body of the device, and when so desired, this shank may be replaced by a clamping mechanism which is secured to the outside of the spindle of the drill press or lathe. This clamping device screws into the body in the same way as the taper shank, and is tightened on the spindle of the machine by means of two screws which compress the split bushing that fits around the spindle.

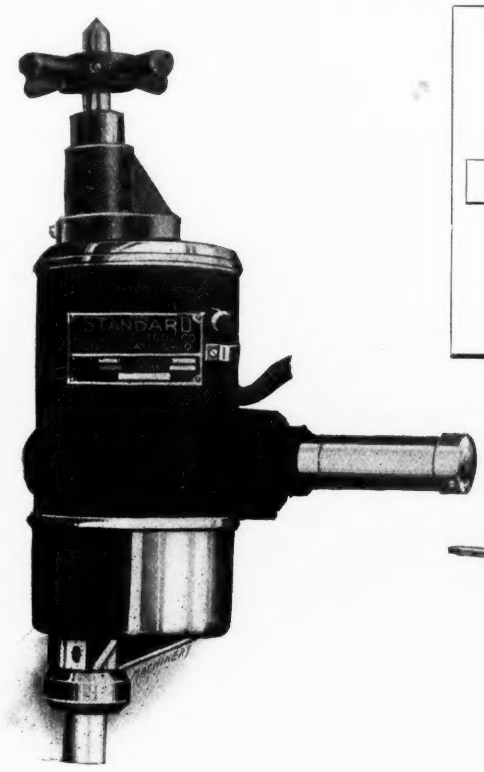
Jarvis Tapping Device with Ball Drive and Quick Geared Return

Special taps are not required for use with this chuck, as the jaws are designed to take the ordinary taps. The tapping device body is made of either steel or aluminum, as desired. The aluminum body has steel bearings and is quite light, making the device very sensitive. This tapping device is made in seven sizes with capacities for tapping holes up to 2 inches in diameter. The capacities of the five larger sizes are 3/8, 5/8, 7/8, 1 1/8, 1 1/2 and 2 inches, respectively.

It will be seen from the illustration that the chuck is provided with two screws for adjusting the jaws. One of these screws actuates the jaws for centering the tap and the other screw controls the floating jaws, which are at right angles to the centering jaws and afford the required grip to hold the tool. In setting a tap in the chuck, the centering jaws are screwed up on the round portion of the shank and the float-

ing jaws are then firmly tightened on the square of the tap. After tightening the floating jaws, the centering jaws are screwed up tight.

It will be seen from the illustration that an adjustable stop is provided which can be set to tap a hole to any required depth. An auxiliary supporting rod is also provided; this rod fits into a socket on the device and a split pin is used to hold the rod in position. The end of this rod bears against the upright of the drill-press or on the ways of the lathe, and serves the purpose of steadying the device while in operation. When the stop is engaged, it releases the ball-drive in the device, and then by pulling up the spindle, the quick-return drive is engaged to back the tap out of the hole.



Standard Portable Electric Drill

STANDARD PORTABLE ELECTRIC DRILLS

The Standard Electric Tool Co., Cincinnati, Ohio, has added to its line high-power direct-current drills of 1/4, 5/16, 3/4 and 7/8 inch in size; these sizes form an addition to the 3/8, 1/2 and 5/8 inch drills of the same type manufactured by this company. These tools are ball bearing throughout and the construction has been designed to provide the necessary rigidity for high-power work. Series motors are employed on these drills, the motors being insulated and impregnated by a special process. All of the gears are generated from chrome-nickel steel and casehardened to give for the necessary wearing qualities; they are supported on both ends and run in grease.

This company has also added to its line of alternating-current drills, tools of the following sizes: 1/4, 5/16, 3/8, 1/2, 3/4 and 7/8 inch. The mechanical construction of these tools is extremely simple and rigid and the electrical connections have been simplified so that the drills have been made practically "fool-proof." The power developed by the motors runs considerably above the rate of capacity, so that the danger of burning them out from overloading is greatly reduced.

MADISON VARIABLE-SPEED COUNTERSHAFT

The illustrations show a variable-speed countershaft which is built in six different sizes by the Madison Machine Co., 310 Carroll St., Madison, Wis. Referring to the illustrations, it will be seen that the countershaft consists of an iron frame carrying two shafts. Two pairs of conical shaped pulleys are mounted on these shafts and a trapezoidal shaped belt runs between them. One of the pulleys of each pair is fixed and the other can be adjusted along the shaft by means of hydraulic pressure from the cylinders on the countershaft. It will be evident that by increasing the space between the pulleys on one shaft, and decreasng the space between the pulleys in the other shaft, the speed ratio will be varied and any desired ratio within the range of the countershaft can be obtained by setting the pulleys in the required positions. The pistons which control the movement of the pulleys are actuated by means of a controller that may be either of the piston type or pneumatic type; where air pressure is available, the pneumatic type is recommended.

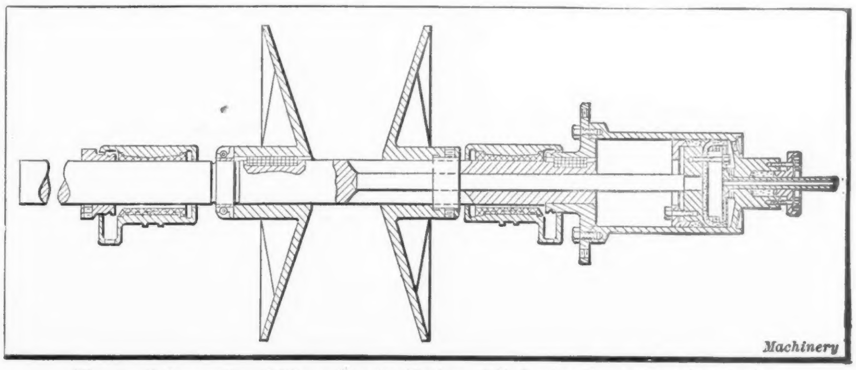


Fig. 1. Cross-sectional View showing Design of Hydraulic Speed-changing Device

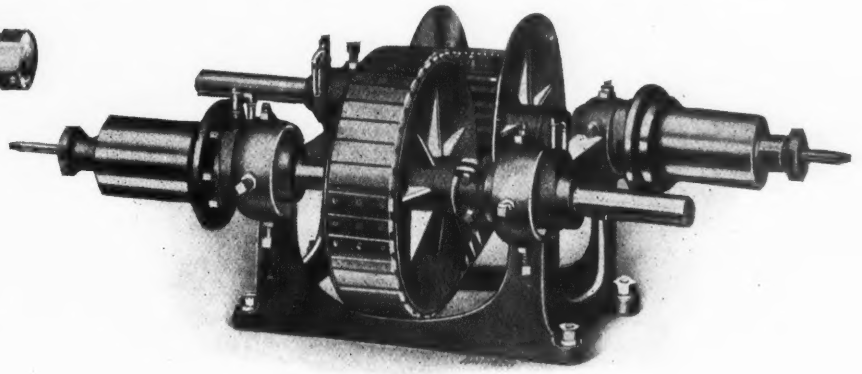
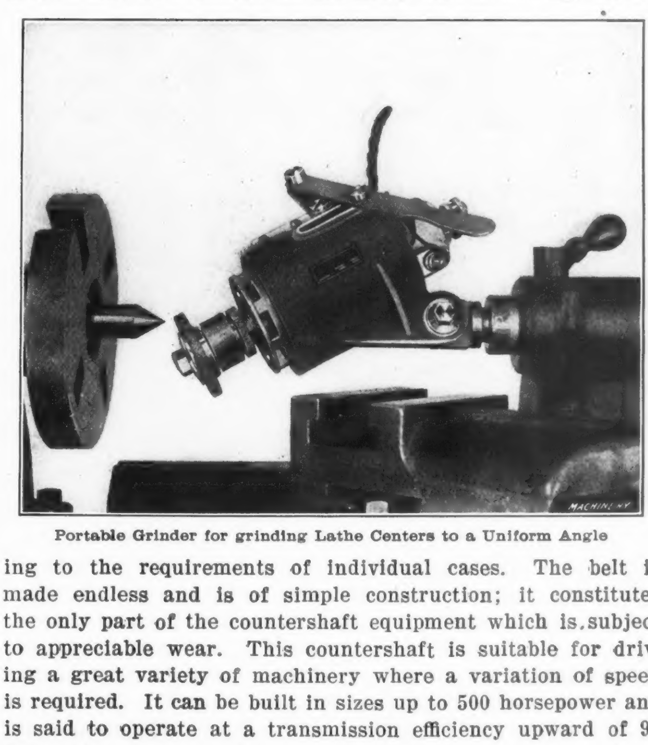


Fig. 2 The Madison Variable-speed Countershaft

This countershaft can be set up in any desired position so that it may be mounted on the floor, wall or ceiling, according to the requirements of individual cases. The belt is made endless and is of simple construction; it constitutes the only part of the countershaft equipment which is subject to appreciable wear. This countershaft is suitable for driving a great variety of machinery where a variation of speed is required. It can be built in sizes up to 500 horsepower and is said to operate at a transmission efficiency upward of 94 per cent.



Portable Grinder for grinding Lathe Centers to a Uniform Angle

SMITH PORTABLE ELECTRIC CENTER GRINDER

A portable electric grinder to be used exclusively for grinding centers is one of the late products of The Smith Electric Tool Co., Cincinnati, Ohio. The illustration gives a very good idea of the general construction of the center grinder. The shank that fits into the tailstock of the lathe has a pin, setting the grinder at 60 degrees; this pin may be changed to set the grinder at any other angle that is required. A desirable feature of grinding centers with this tool is that all centers in a shop can be maintained at a uniform taper, the standard being 60 degrees. This allows the center holes in all the various size arbors to be uniform, thus making the arbors interchangeable on different lathes. This advantage is apparent when it is necessary to shift work from one lathe to another, the bearing end in each center being the same, thereby establishing absolute truth to the periphery of the arbor or work mounted on it.

The operation of grinding centers is so simple that it requires no skill on the part of the operator. With the grinder mounted at the correct angle, it is inserted in the tailstock of the lathe. The adjustment for cut is made by the tailstock screw, no other adjustment being required. For doing accurate work, the great saving of time effected by this tool, as compared with setting up a tool-post grinder for grinding centers, can be readily appreciated.

The motor is of special design, having high efficiency and other features of advantage in grinding. The armature shaft is made of nickel steel, ground and lapped. The phosphor bronze end bearing is adjustable and can be kept in the exact condition for perfect grinding. Grinders are shipped with a blank shank, accurately centered ready to be turned to fit the tailstock of any lathe. When the same grinder is operated on lathes having different size tailstocks, bushings can be used. The grinder can be run from any direct current lamp socket.

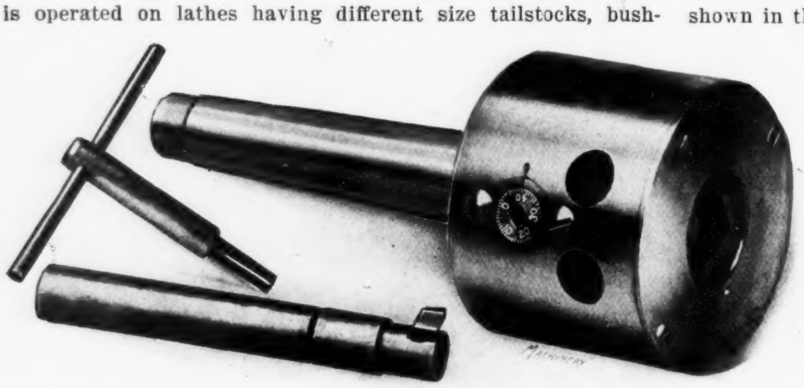


Fig. 1. No. 10 Flynn Chuck fitted with Universal Three-point Contact Jaws

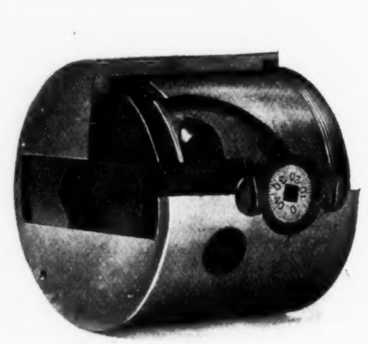


Fig. 2. Partial Sectional View of the No. 10 Flynn Chuck

FLYNN COMBINATION DRILLING AND BORING CHUCKS

The illustrations show two styles of combination drilling and boring chucks which have recently been placed upon the market by the J. T. Flynn Mfg. Co., Detroit, Mich. The No. 10 chuck shown in Fig. 1, is fitted with universal jaws which are operated by two screws, one of which is intended for adjusting the jaws and tightening them on the shank of the tool, while the other is an auxiliary jaw for securing a firmer grip in cases where a more positive drive is required. Referring to Fig. 2, where a partial sectional view is shown, the design of the chuck will be better understood. Here it will be seen that the jaws are male and female, V in shape, and that they are held aganst the front of the chuck by means of a nut at the back of the shell. This arrangement is more clearly shown in the illustration of the chuck details, in Fig. 3.

Fig. 3. Parts of the No. 10 Flynn Chuck

The screw with a dial head is used for centering the jaws when the chuck is used for drilling, or for setting them at any required distance off center, where a boring bar is mounted in the chuck. The jaws provide a three-point bearing on the shank of the tool $1\frac{1}{2}$ inch in length and afford ample power for drilling and boring operations within the range of the

Fig. 4. The No. 8 Flynn Chuck graduated on Face for Different Drill Sizes

chuck. The dial of the adjusting screw is graduated to thousandths and provides for setting the boring bar at the desired distance off center for counterboring, recessing and parallel boring; this adjustment makes the chuck particularly adapted for boring jigs and fixtures. The chuck has an offset of 3/8 inch and will take drills or bars up to 3/4 inch in diameter. The capacity for boring holes ranges up to 4 1/2 inches diameter.

This chuck has a 3/4-inch hole running through it, and by screwing the chuck onto the lathe spindle, instead of using the taper shank, a convenient means is provided for working from long bars or for turning straight or eccentric pins.

Fig. 4 shows another style, known as the No. 8 chuck, which is of practically the same design as the style shown in Fig. 1. This chuck has a solid cross-block with a V in it which acts in conjunction with a second jaw in the chuck. It will be seen that the face of the chuck is graduated for different drill sizes. The dial of the adjusting screw is graduated in thousandths to correspond with the graduations on the face of the chuck and provides for setting the cross-block central for different drill sizes. The same style of chuck is also made in a smaller size, known as the No. 6, which accommodates 3/8-inch boring bars and has a range for boring holes up to 2 inches in diameter.

The design of these chucks is simple and compact and particular attention has been paid to the provision of the necessary rigidity and rapidity of adjustment. All parts that are subject to wear have been hardened.

OLIVER EMBOSSING AND FORMING MILL

The work of forming strip sheet metal to any required shape, or of embossing a design upon stock of this kind, is often performed by means of a rolling mill equipped with rolls of the required shape. There are, however, certain limits in the amount to which the metal can be formed in passing through one set of rolls, and when this limit is exceeded, it becomes necessary to pass the work through two or more sets of rolls.

One of the recent products of the W. W. Oliver Mfg. Co., 1500 Niagara St., Buffalo, N. Y., is the rolling mill shown in the accompanying illustrations. This machine consists of the regular No. 4A, triple-geared, power rolling mill manufactured by this company to which a second roll frame has been attatched. The rolls carried by the second frame are driven at the correct speed by a chain from the rolls in the first frame. This machine has been the means of effecting a considerable saving of time in operations where the stock is to be formed to such an extent that two pairs of rolls are necessary.

One class of work produced by this machine consists of strips of sheet tin 0.010 inch in thickness which are embossed and crimped by passing through the mill. In this case, the rolls of the No. 4A mill, perform the embossing operation and the auxiliary pair of rolls put the crimp in the work. The stock is fed straight through from the embossing rolls to the crimping rolls without any loss of time, so that the machine operates at a high efficiency.

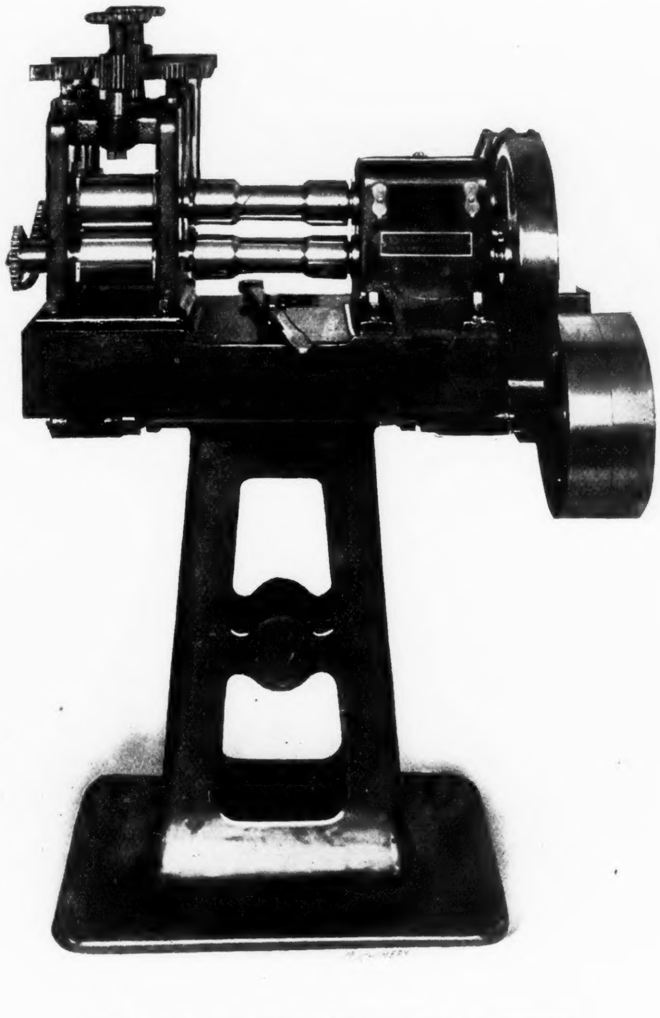


Fig. 1. The Oliver Rolling Mill for forming or embossing Strip Sheet Metal

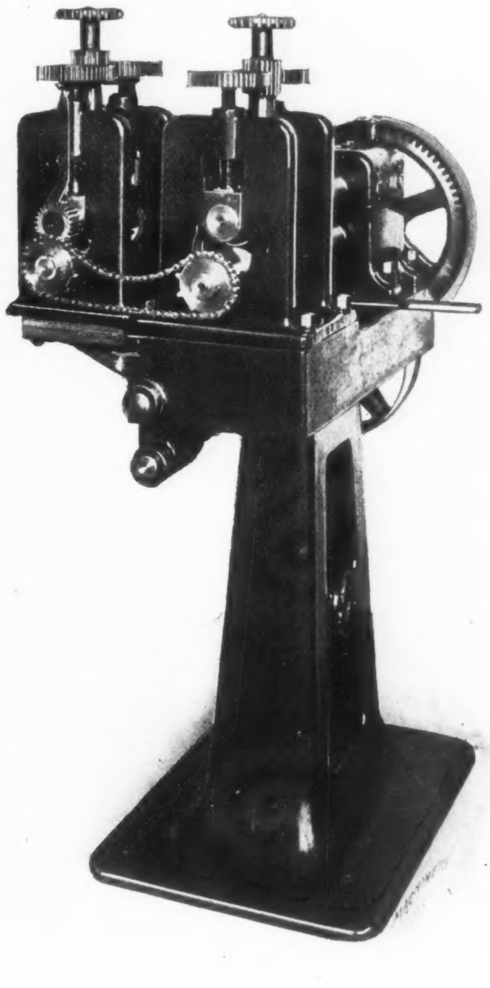


Fig. 2. Side View of Machine showing Chain Drive and Auxiliary Roll Frame

CONOVER-OVERKAMP MOTOR-DRIVEN LATHE

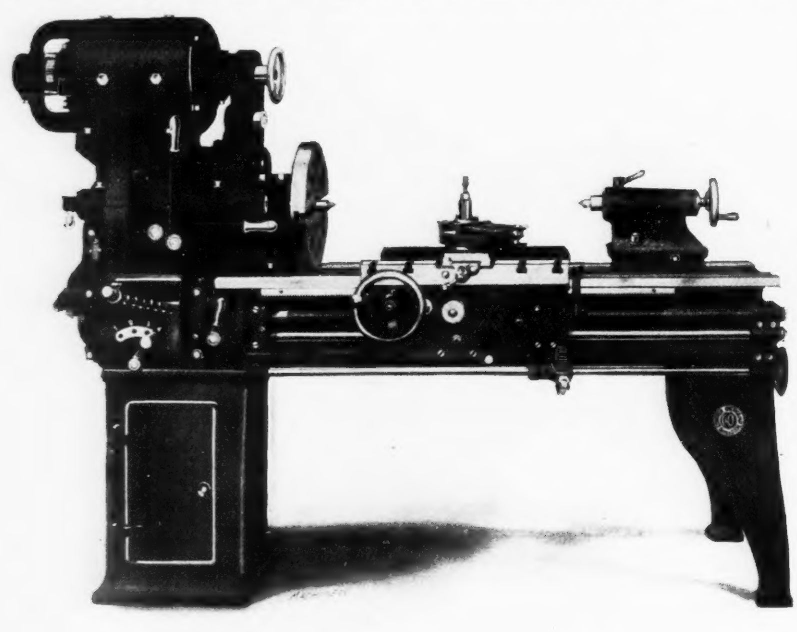
The Conover-Overkamp Machine & Tool Co., Dayton, Ohio, has brought out a new motor-driven lathe, illustrated herewith, built in 14- and 16-inch sizes. The headstock is ribbed to support the strain of the cut and is cast in two sections. The lower half forms the headstock proper, and the upper half provides a base for the motor, completely covering all running parts and doing away with loose gear guards. The backgears on this lathe are placed in front, instead of being on the back of the headstock, making them accessible to the operator without going around the lathe to throw them in or out. This feature enables these lathes to be placed close to the wall, thus effecting a saving of floor space.

The drive is obtained from the pinion on the motor shaft through an intermediate gear to the friction gear on the lathe spindle. By means of this friction gear on the spindle, the lathe may be started or stopped while the motor is running, thus allowing the motor to retain its normal speed. This friction gear is operated by the horizontal lever on the headstock. The headstock is equipped with other single back gears, or double friction back gears. When equipped with double friction back gears, these gears are operated by the vertical lever on the front of the headstock.

With a 3 to 1 variable-speed, direct current motor, a range of spindle speeds from approximately 13 to 400 R. P. M. may be obtained, allowing ample speed for all classes of work. The motor is controlled through a drum type controller, and is operated by a lever on the apron. The position of this lever is to the right of the operator and working in a vertical position places it in the most convenient and natural position for him to handle. As all working levers on this lathe are at the front, the operator has complete and quick control at all times, saving many unnecessary steps. The dimensions of these lathes are the same as the standard 14- and 16-inch machines built by this company, and the motor-driven type can be furnished with quick change gear, as shown in the illustration, or with an all geared feed or standard belt feed.

NIAGARA COMBINATION FLANGING MACHINE AND ROTARY SHEAR

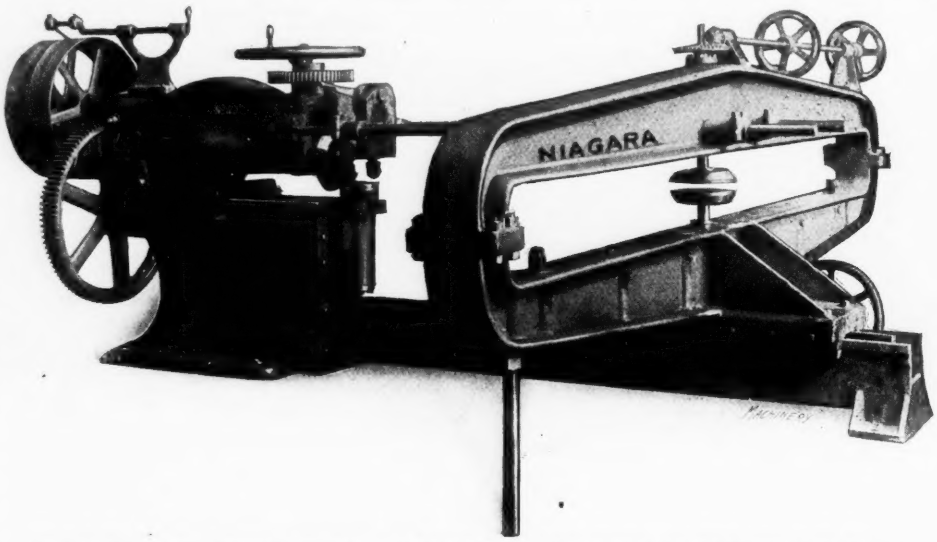
The combination flanging machine and rotary shear illustrated herewith is a recent product of the Niagara Machine & Tool Works, Buffalo, N. Y. As shown, the machine is set up for flanging operations, and to convert it into a rotary shear the flanging rolls are removed and shear blades mounted in their place.



Conover-Overkamp Motor-driven Lathe, built in 14- and 16-inch Sizes

Referring to the illustration, it will be seen that there are two horizontal shafts driven at the rear end by gears. A pair of miter gears connect the lower shaft with a vertical shaft which supports he lower flanging roll; the upper flanging roll is mounted on the upper horizontal shaft. The shaft carrying the upper flanging roll can be raised and lowered by a hand-wheel and the roll can be adjusted laterly to accommodate different thicknesses of stock.

The clamping or circle arm is mounted on the extension of the bed, which is fastened to the main frame, and provision is made to adjust the arm for disks of different diameters. To insure rigidity, the upper part of the clamping arm is tied to the frame by means of two heavy shafts and these shafts serve the further purpose of supporting a hold-down attachment which can be quickly raised and lowered by means of an eccentric lever. In starting a flanging operation, the metal is first cut to a circular shape of the required diameter and is then clamped between the two disks of the circular arm. The upper flanging roll is then gradually brought down and forms the flange over the lower roll. The machine is shown in the illustration equipped with rolls to form a 90 degree angle flange.



Niagara Combination Flanging Machine and Rotary Shear set up for forming 90-degree Angle Flanges

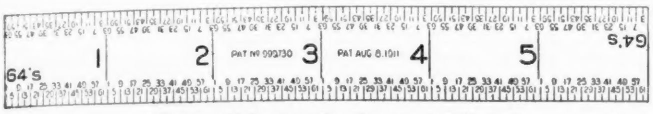
This machine has a capacity for metal as heavy as 1/4 inch in thickness, and it will flange disks from 18 inches to 12 feet in diameter with a maximum height of 2 1/2 inches for the flange. When used as a circular shear, it will cut out disks from 14 inches to 9 feet 2 inches in diameter, from a square blank.

A NEW LUFKIN RULE

Everyone who has used a scale graduated down to 64ths of an inch, knows the difficulty of obtaining accurate measurements, and the eye-strain and loss of time resulting from the fineness of the lines, and the closeness of the lines to one another that is necessary to get 64 lines in an inch. Under the eye, the lines seem to have a tendency to "run together," and because they are so close it is impossible to number each one; therefore, after arriving at the meaurement, it is necesssary to refer back to the last figure and count up the 64ths. It is evident that if the same measurement could be arrived at with the same degree of accuracy with a rule graduated not finer than say 16 lines to the inch, these difficulties would be overcome.

Both of these features are combined in the Allen improved scale, which has just been put on the market by the Lufkin Rule Co., Saginaw, Mich. This is a patented tool which embodies an absolutely new idea in the marking of a machinist's scale. As any even number of the 64th has an equivalent in 32nds and 16ths, one side of this rule is graduated in 32nds and 16ths, and this takes care of all of the even 64ths. The other side of the rule embodies the new idea that takes care of all the odd 64ths. The first graduation mark on one edge of this side is 1/64 inch from the end of the rule and is numbered "1"; the next mark on that edge is 5/64 inch from end of rule, and is numbered "5"; the next

"9"; the next "13," etc., up to the first inch mark. This system of graduation is repeated in each inch. Here there are intervals of 4/64ths, and between 1/64th and 5/64ths would come one odd 64th, *i. e.*, the 3/64th inch mark; between the "5" and "9" graduations would come the 7/64th inch



Allen Improved Scale which gives Readings to 1-64th Inch, with only 16 Graduations to the Inch

mark, etc. All of these odd 64ths appears on the other edge of this side of the rule; that is, the first graduation mark there is 3/64 inch from the end of the rule, and is numbered "3"; the next is 7/64 inch and numbered "7," etc., in each inch.

Thus the object is accomplished; all of the odd 64ths are here given, and yet there are only 16 lines to the inch. This makes it possible to number each graduation mark, and by marking each second graduation mark slightly longer than the one before and after it, the figures can be put on in two rows, and this allows sufficient room to make them large enough to

Fig. 1. Bickford No. 1 Plain Milling Machine equipped with Tap Squaring Fixture

be easily read. The rule is ¾ inch wide, and furnished in the two thicknesses commonly known as the "tempered" and th? "semi-flexible"; it is made in various lengths, but the greatest demand, no doubt, will be for the 6-inch length.

BICKFORD TAP SQUARING FIXTURE

In the November, 1910, issue of MACHINERY, the No. 1 plain milling machine manufactured by the Bickford Machine Co., Greenfield, Mass., was illustrated and described. The accompanying illustrations show a recent modification of this machine which has been developed by the Bickford Machine Co., to adapt it for squaring taps. For this purpose the machine has been equipped with a foot treadle to operate the feed, and a chucking device which consists essentially of a steel head arranged to make a quarter revolution in a cast-iron frame. A detail of this chucking device is illustrated in Fig. 2. One of the two handles is screwed firmly into one side of the head and the other is so connected that it operates the chuck which has a tapered nose to fit a corresponding taper in the head. By simply bringing these two handles together the chuck is forced forward into the tapered section of the head and closes firmly upon the work. The chuck may be closed in this manner by bringing the two handles together in either a vertical or horizontal position.

With the work gripped in the chuck in the manner previously described, the treadle is pushed down to feed the work to the cutters which perform the squaring operation. After taking a cut in this way the two handles are swung through a quarter revolution and the treadle is then pushed down to feed the work through the cutters a second time. This completes the squaring operation. This machine will square work from 1/8 to 7/16 inch in diameter and has a capacity from 300 to 400 pieces per hour.

CONRADSON TURRET TOOLPOST

The illustrations show a new turret toolpost which has been designed and placed upon the maket by Phoenix Mfg. Co., Eau Claire, Wis. This toolpost is intended for use on a regular engine lathe and for many classes of work, it will give a machine of this type the productive capacity of a turret lathe.

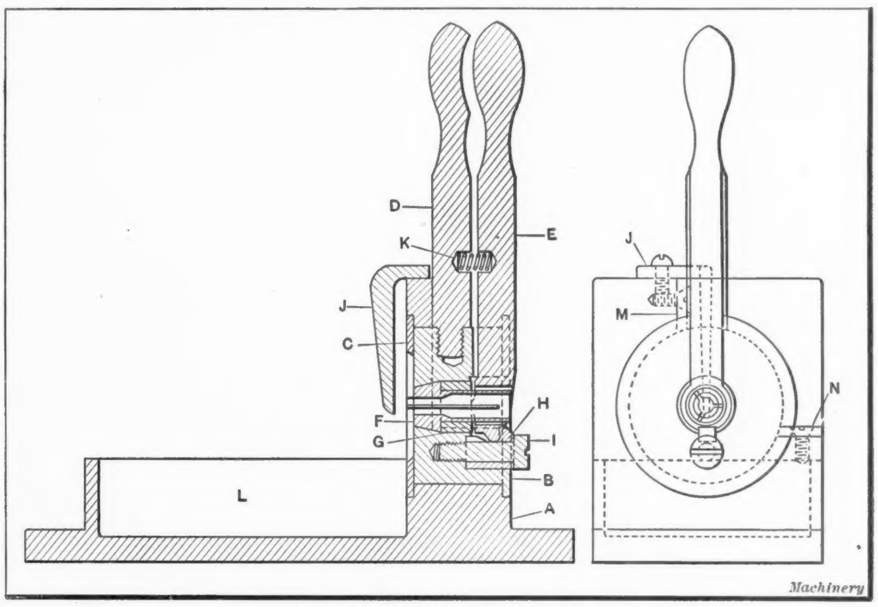


Fig. 2. Chucking Device used for Tap Squaring

This toolpost is not ordinarily recommended for use on work where an intelligent analysis indicates that a turret lathe is necessary, but it has an extremely wide field of application on operations which come between those regularly performed on an engine lathe and a semi-automatic or hand turret lathe.

Referring to the cross-sectional view of the turret toolpost, shown in Fig. 1, it will be seen that this equipment consists of a bracket *A* mounted on the cross-slide of the lathe; this bracket supports the steel bushing *B* in which the turret *C* is free to rotate or to be moved longitudinally for a sufficient distance to disengage the indexing mechanism. The turning tools are carried in toolposts held in bosses on the front of the turret, and the boring tools, of which a great variety may be employed, are held in the split collet sleeve *E*. A reversible boring bar *F* is ordinarily used for holding two interlocking cutters at one end, and this bar has a collet at the opposite end which is used to hold a variety of boring tools, such as those illustrated in Fig. 5. The tool *J* is the cheapest form of tool that can be made, and is used where only two cutting edges are needed. This tool is forged from high-speed steel and is simply flattened out to produce two cutting lips. High-speed steel can be economically used, as the tool can be re-bored any number of times. The tool *K* is of more elaborate design and is intended for boring small holes where more than two cutting edges are needed; this tool provides for roughing and finishing a hole, and can also be fitted with a roughing and finishing thread tool. The bit is made of high-speed steel and the bar of vanadium steel, the bit being screwed into the end of the bar. The collet *E*, Fig. 1, is tightened by means of the differential nut *G* which is turned by

means of the capstan *H*. When the turret toolpost is being used for turning operations, the collet is loosened and the bar slid back out of the way, as shown in Fig. 3.

The indexing of the turret is accomplished by means of the teeth *D*, shown in detail in Fig. 2, which are located between the sleeve *B* and turret *C*. There are eight teeth and eight corresponding spaces, and a "ball finder" *J* is provided which automatically registers the turret when it is brought to approximately the indexing position. The turret is then simultaneously indexed and clamped by operating the handle *I*; this draws in the turret and engages its teeth with the spaces on the sleeve *B*. The design of the clamping mechanism takes up all lost motion.

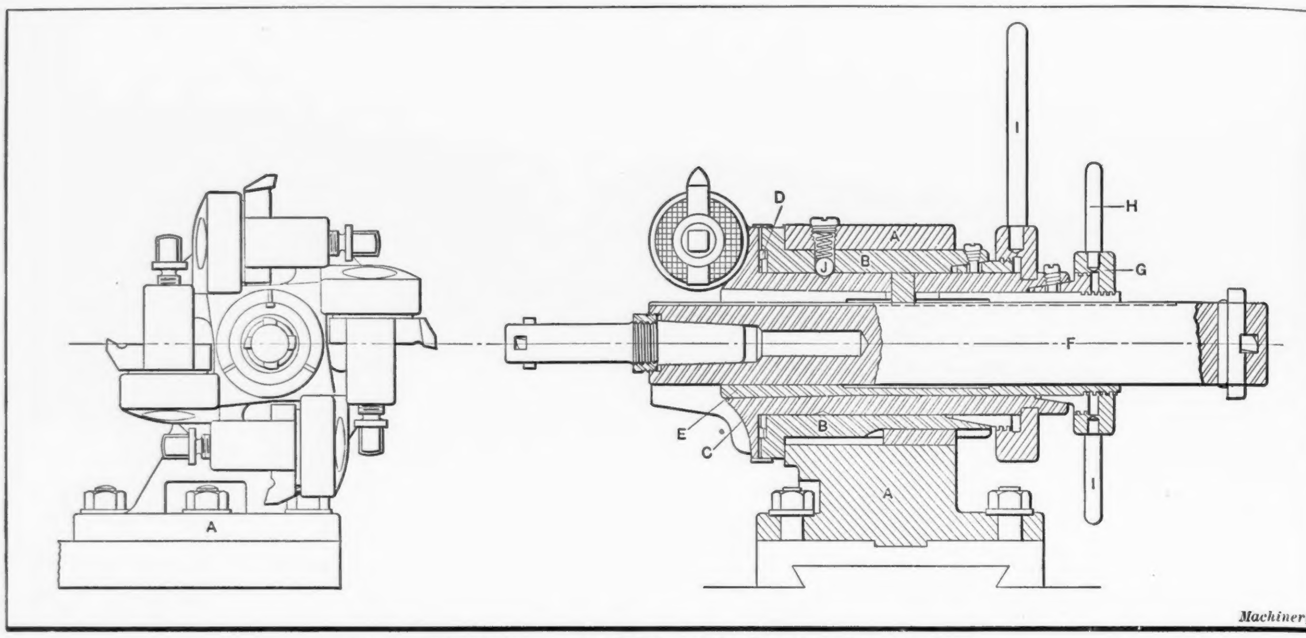


Fig. 1. End and Cross-sectional Views of the Conradson Turret Toolpost

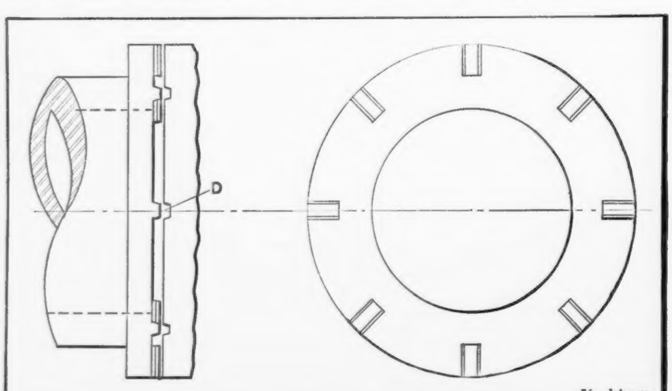


Fig. 2. Detail of the Teeth of the Index Mechanism

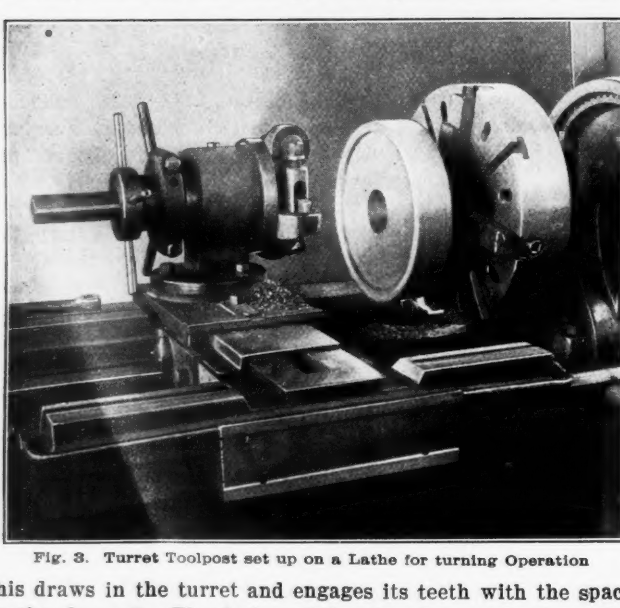


Fig. 3. Turret Toolpost set up on a Lathe for turning Operation

Figs. 3 and 4 show the tool mounted on a lathe ready for the turning and boring operations, respectively, and give a good idea of the class of work for which this turret toolpost is particularly adapted. The work shown in these illustrations is 13½ inches in diameter and parts of this design were completely machined in about twenty-five minutes each. A comparison of this time with the time required to produce such work on an ordinary engine lathe, will emphasize the productive capacity of the tool, and on jobs calling for a small number of pieces the turret toolpost will finish the work in the time required to set up a turret lathe. On those classes of work which this toolpost is best suited, it will keep up with a turret lathe engaged on the same operation. It will be seen from the preceding that this toolpost is particularly adapted to the requirements of shops engaged in manufacturing operations in small lots.

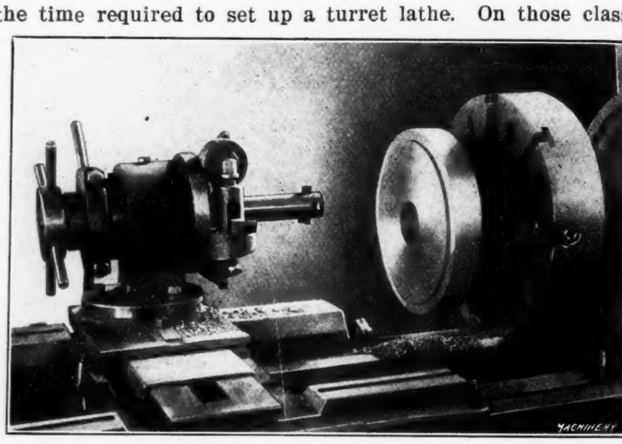


Fig. 4. Turret Toolpost set up on a Lathe for Boring Operation

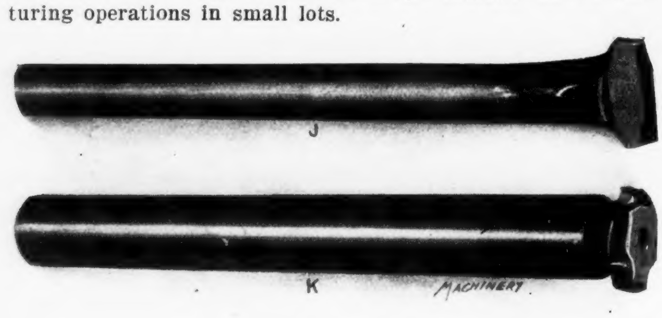


Fig. 5. Two Styles of Boring Tools used in the Turret Toolpost

The tool equipment required for this attachment is extremely simple. It is necessary to have a sufficient number of boring bars to cover the range of the toolpost and about twelve turning tools will cover all ordinary requirements. It is often found particularly convenient to use the reaming and

tapping attachment shown in Fig. 6 in connection with this turret toolpost. In using this attachment, the turret is drawn back out of the way, the reamer or tap then being swung down into alignment with the spindle and advanced to the work. The design of this toolpost fits it for the most severe classes of manufacturing operations which come within its range, and this fact will be readily appreciated from the statement of the manufacturer that the toolpost has frequently stalled a 24-inch engine lathe.

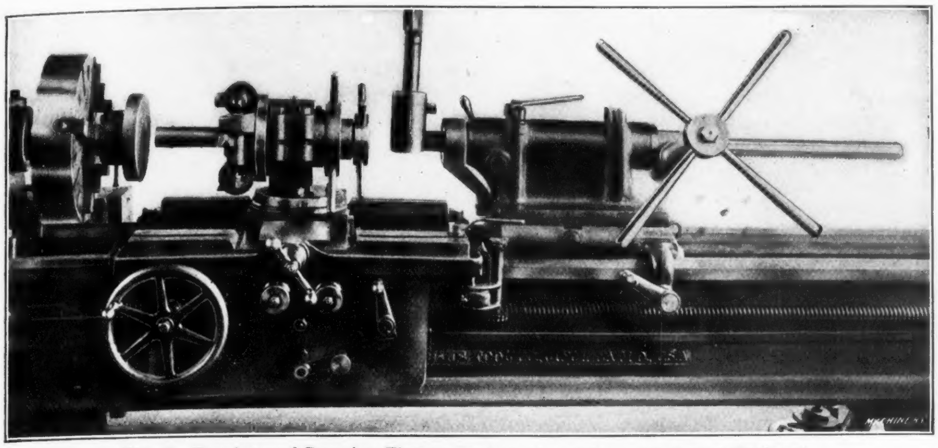
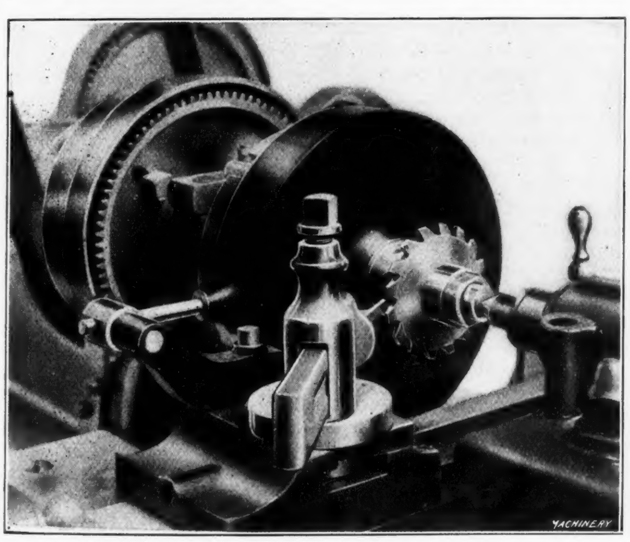


Fig. 6. Tapping and Reaming Fixture used in connection with Turret Toolpost

THE BICKFORD RELIEVING ATTACHMENT

The relieving attachment shown in the accompanying illustration is a recent product of the Bickford Machine Co., Greenfield, Mass. The essential parts consist of a shaft running on eccentric centers and carrying a sleeve upon which the cutter that is to be relieved is mounted, a 64-tooth gear attached to the sleeve and a 60-tooth gear free on the sleeve, and a pinion mounted on an arm carried by the eccentric shaft which meshes with the two gears. The 60-tooth gear is attached to the inside of the gear guard, shown in the illustration, and as this gear cannot revolve around the sleeve upon which the cutter is mounted, the sleeve and cutter are rotated, the motion being the result of the difference in the numbr of teeth on the two gears. The cutter is also carried around in a circle by the eccentric shaft, thus being carried toward and away from the tool as well as up and down.



Bickford Attachment for relieving Cutter Teeth

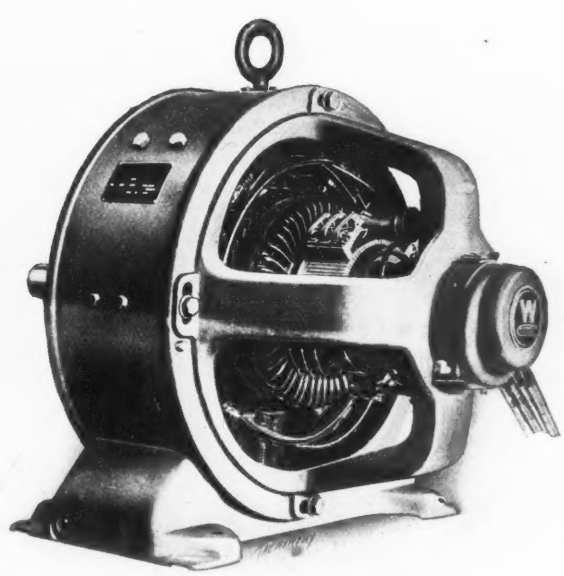
One quarter of the circumference of the idle gear has 18 teeth and the other three quarters have 42 teeth. The result of this unequal spacing of the teeth gives the following result. The cutter which is being relieved revolves in the opposite direction to that in which the lathe is running during the time that the cutter is passing from its point nearest the tool to the lowest point of its travel, and during the balance of the movement of the cutter in its circular path it revolves in the same direction as the lathe. When the cutter has again reached its position nearest the tool, it will have advanced 1/16 of a revolution as the result of one planetary revolution.

This movement makes it possible to run the cutting tool right up to the face of the tooth and the cutter will then revolve backward while it is receding from the tool, instead of moving forward and taking off the end of the tooth. This makes it possible to have teeth which are very wide, and spaces between the teeth which are relatively narrow.

A method of adjustment is provided by means of two small screws which will revolve the cutter through the space of one tooth. By this means it is possible to set the tooth in the correct relative position to the tool before starting the cut. Any cutter having 16 teeth, a one-inch hole and a face width of not over 1 1/2 inch may be relieved on this attachment.

WESTINGHOUSE MOTOR FOR DRIVING BENDING ROLLS

A new Westinghouse motor which has just been placed on the market is especially designed for driving bending rolls, raising the cross rails of planers and boring mills, moving the tail-stocks of large lathes, and similar service requiring motors with special torque characteristics. The special feature of this motor is that most of the excitation is due to the series coils. The torque, therefore, increases rapidly as the current input increases, and this is the characteristic that is necessary to adapt the motor for such classes of service as starting a cross-rail or taking a plate through a pair of bending rolls. The shunt field winding, limits the no-load speed to approximately twice the full load speed, so that racing is impossible.



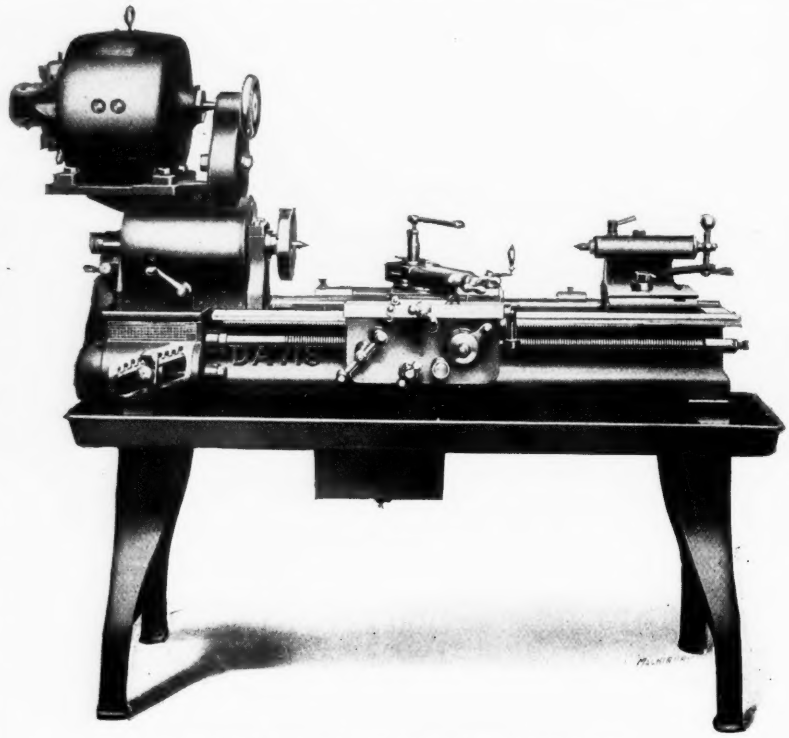
Westinghouse Motor for driving Bending Rolls

Mechanically, these motors are exceptionally strong. The frame is made of rolled steel, the shaft of axle steel, and the bearings are very large and designed to make them dust and oil proof. The commutation is practically sparkless, due to the use of commutating poles and the careful design of the commutator and brushes. The manufacturers state that these motors require very little attention, as the lubrication is automatic and the brushes rarely require renewal. They are made by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., in capacities of from 3 to 40 horsepower to operate on 230 volt direct-current circuits.

DAVIS MOTOR-DRIVEN LATHE

The illustration shows the variable-speed motor-drive as applied to lathes of 12- to 16-inch swing manufactured by the W. P. Davis Machine Co., 305 St. Paul St., Rochester, N. Y. Referring to the illustration, it will be seen that the motor is mounted on a substantial plate located above the head-stock and so placed that the weight of the motor is supported without producing any tendency toward vibration.

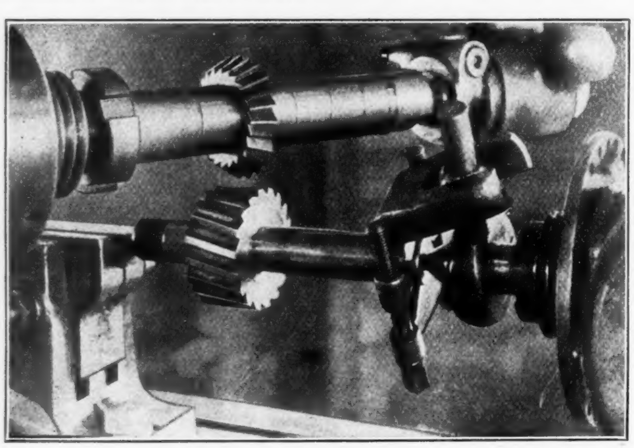
A useful feature of this motor-drive consists of having the armature spindle extended and fitted with a hand-wheel which affords a convenient means of turning the lathe spindle over by hand when setting up or testing the work. The motor is direct-connected to the spindle through an intermediate gear and the drive from the spindle is either direct or through single or double back-gears, which provide two or three mechanical changes. All of the gearing is adequately covered by cast-iron gear guards. The controller can be mounted at any place along the lathe bed, but experience has shown that the best position is either at the head end or in the rear at the back of the tail-stock. The controller is operated by a lever located on the apron, where it is within easy reach of the operator. Any make of variable-speed direct-current motor can be used. On sizes up to 3 H.P., a speed ratio of 3 to 1 giving speeds of from 500 to 1500 R. P. M. is used. The Cutler Hammer No. 78 full reverse drum type controller is used.



Davis Lathe equipped with Variable-speed Motor Drive

"READY" COMPENSATING MILLING MACHINE DOG

In the November, 1912, issue of MACHINERY, the Hill compensating dog for milling taper work was described. The features of this dog were the forked driver mounted on the spindle or faceplate and a dog having a tail with a ball shaped part engaging the fork of the driver. The design of this dog brings the point of application of the forked driver on the ball into approximately the same plane as the end of the piece being indexed. This arrangement eliminates the irregular spacing that occurs in indexing tapered work when an ordinary bent-tail dog is used.



Improved "Ready" Milling Machine Dog for Taper Work

The dog shown herewith is an improved design which is claimed to combine the advantages of the preceding type with the ability to drive work that has to be held on a short arbor with the table swung over at an acute angle, and still allow the dog to clear the overhanging arm. In the preceding design of this dog, the driving fork was clamped to the face plate or spindle of the index head, and the tail carrying the sliding ball was attached to the dog. In the present design, it will be seen that the driving fork is mounted on the dog and reaches back to engage the ball carried on the tail attached to the collar on the spindle. It will also be seen that the driving fork is set at an angle. In this way, the advantages of the old dog are secured and the dog clears with the work on a short arbor and the table set over at an acute angle. Both the dog shown in the illustration and the one previously referred to are products of the Ready Tool Co., 654 Main St., Bridgeport, Conn.

NEW MACHINERY AND TOOLS NOTES

Ball-bearing Shaft Hanger: Gurney Ball Bearing Co., Jamestown, N. Y. A ball-bearing shaft hanger that can be adjusted in all directions and swiveled universally. The yoke swings in a cored-out housing in the hanger and the housing is extended inward around the yoke.

Metal Tool-case: Peck-Hamre Mfg. Co., Berlin, Mass. A machinists' tool-case made entirely of metal and provided with drawers lined with felt. The case can be quickly closed and locked and is especially suitable for resisting hard service.

Cutting-off and Centering Machine: Holton Co., Jackson, Mich. Sixteen collets are provided on this machine for taking round stock varying in size by eighths of an inch. The machine is equipped with a centering device which can be readily attached or detached, or can be left on the machine without interfering with cutting-off operations.

Vertical and Horizontal Rotary Oscillating Surface Grinder: The Springfield Mfg. Co., Bridgeport, Conn. An improved model of the machine of this type peviously manufactured by the above company. The horizontal grinding head is of the previous design but the vertical head is fitted with a counterbalance and quick return hand-feed.

Multiple-spindle Drilling Machine: Moline Tool Co., Moline, Ill. A four-spindle drilling machine with the tables and feeds entirely independent, but with all of the spindles on one drive. This machine is of the double cam feed type regularly built by this company and means are provided for changing the cams to suit different classes of work.

Sensitive Drilling Machine: J. E. Snyder & Son, Worcester, Mass. A 21-inch sliding head, high-speed drilling machine with the spindle driven by bevel gears. The machine is designed to drive drills from 1/8 to 7/8 inch in size, and has feeds of 0.003, 0.006 and 0.010 inch per revolution of the spindle.

Three-jaw Clamp: M. A. Haskell & Co., South Braintree, Mass. A convenient clamp for holding irregular shaped pieces of work. The clamp is made of steel and is opened and closed by turning a handle which actuates the clamping screw. The middle jaw can be removed when it is desired to convert the tool into a two-jaw clamp.

Hydraulic Bulldozer: Watson-Stillman Co., 192 Fulton St., New York City. A hydraulic bulldozer designed for use in the manufacture of heavy motor-truck axles but adapted to a variety of other forging operations. This machine has three

rams connected to a single head, and the number of rams used may be varied according to the power required.

Oxy-acetylene Welding Outfit: F. C. Sanford Mfg. Co., Bridgeport, Conn. The generator of this outfit is designed to operate at low pressure, intermediate or high pressure for small, medium and heavy work, respectively. The changes of pressure are effected by operating a handle, and when the desired pressure is reached the generator requires no further attention.

Eye Protectors: American Spectacle Co., 27 W. 23d St., New York City. Three forms of goggles especially designed for protecting the eyes of workmen engaged in operating chipping hammers or grinding machines. The goggles are also serviceable for those engaged in handling molten metals, electric or oxy-acetylene welding operations and any other service of this class.

Ball-bearing Shaft Hanger: New Departure Mfg. Co., Bristol, Conn. An improved ball-bearing shaft hanger designed especially for use with he annular type of self-aligning ball-bearings manufactured by this company. The frame of the hanger is made of a gray iron casting of box-section, the ends of which are closed by a cap after the shaft is in place. The bearing is carried by a machine retainer ring supported in the hanger frame by four set-screws.

Vertical Planer-type Grinder: Springfield Mfg. Co., Bridgeport, Conn. This is an improved form of the machine of the same type previously manufactured by this company, but is of considerably larger size, having a capacity for grinding work up to 14 feet in length. The important feature of this machine lies in the provision of means to tilt the housings carrying the vertical grinding spindle to enable the machine to grind concave work.

Roller Mandrel: Alert Tool Co., Philadelphia, Pa. A mandrel with a small hardened roller carried in a longitudinal slot milled off center along the face of the shank. This allows the roller to drop below the circumference of the mandrel, and the more strain that is placed on the work, the more securely does this small roller bind and secure it upon the mandrel. To release the work it is only necessary to turn in the opposite direction, thus releasing the grip of the small roller.

Tool-post Turret: Carson & Hartwig, 25 Hackett St., Newark, N. J. This tool is provided with a threaded vertical sleeve which provides vertical adjustment for aligning the turret with the centers of the lathe to which it is applied. The turret is five inches in diameter and has six holes for round shank tools, and has also been provided with means for holding six 5/16-inch square turning tools. The turret is rotated by a lever at the rear and an index pawl locks the turret in either of the six positions.

Automatic Profiler: Charles R. North, 41 Seymour St., Hartford, Conn. This machine has the automatic operating device applied in connection with the two spindles of the machine, the driving drum being placed at the back. A bracket is mounted at the rear of the machine between the driving drum and the profiling head, and this bracket carries a shaft upon which two cams are mounted. The cam nearest the head actuates the cross movement of the head on the rail and the other cam actuates the profiling table at right angles to the rail.

Universal Milling Machine: Oesterlein Machine Co., Cincinnati, Ohio. A 20 by 7½ by 17 inch universal milling machine, the chief features of which are as follows: The cone pulley is of an improved type with larger steps than w re formerly employed, and the back-gear is placed inside the column of the machine below the spindle. The arbor is driven with a clutch in front of the spindle, in place of the tongue on the end of the arbor. The column is provided with oil wells for the spindle, and the knee is locked with a taper sliding gib clamped along the whole face of the column and operated by a single lever. Hand-wheels are provided for cross and vertical adjustment and the machine has automatic cross-feed.

Plain Milling Machine: Rockford Milling Machine Co., Rockford, Ill. A plain milling machine equipped with a single drive pulley located at the back of the machine, and driven direct from the lineshaft. The drive is transmitted through a series of change gears mounted inside the column, which affords sixteen spindle speeds ranging from 15 to 360 R. P. M. Fourteen changes of feed are obtained through gears located in the lower part of the column and operated through two levers located on the column below the speed change levers. The speed range is from 1/2 inch to 18 inches per minute. The spindle runs in phosphor-bronze bearings which are easily adjusted, and all other shafts run in Hyatt roller bearings of the high-duty type. The oil pump is located at the back of the machine and driven through gears from the main driving shaft, and works constantly when the machine is in operation. The bottom part of the column forms an oil reservoir through which the oil is pumped in a constant stream to the cutting tools.

Double-spindle Ring-wheel Grinder: Charles H. Besly & Co., Chicago, Ill. A double-spindle, ring-wheel grinding machine, adapted for simultaneously grinding two parallel sides of a piece. The machine is equipped with 18-inch ring-wheels and is of such massive construction as to adapt it for continuous service in severe classes of manufacturing work. The two heads are mountd on V-ways planed on the bed casings; the head at the left-hand side of the machine is bolted in position and the head at the right-hand side of the machine can be moved along the bed and clamped in position to grind work of any desired length within the capacity of the machine. A telescoping dust-hood is hinged at the back to give free access for changing grinding wheels, and has an air-tight connection at the back of the machine for exhausting the grindings removed from the work. The spindle and thrust bearings are lubricated from compression cups, and oil grooves are so placed that the lubrication is forced to the points where it is needed.

* * *

PERSONALS

E. T. Hendee, formerly assistant to the president of Joseph T. Ryerson & Son, Chicago, Ill., has been elected secretary of the company.

Harvey Higgins, Jr., has been appointed advertising manager of the Standard Tool Co., Cleveland, Ohio, succeeding L. F. Hussey, resigned.

Allen Kendall, formerly with the E. B. Van Wagner Mfg. Co., Syracuse, N. Y., is now connected wtih the Buffalo Copper and Brass Rolling Mill, Buffalo, N. Y.

F. B. Jacobs, formerly with the Carborundum Co. of Niagara Falls, N. Y., and an occasional contributor to MACHINERY, is now with the Abrasive Materials Co. of Philadelphia, in the capacity of traveling salesman.

Melville W. Mix was for the fourth time, re-elected president, at the recent annual meeting of the Manufacturers' Bureau of Indiana. Mr. Mix is president of the Dodge Mfg. Co., Mishawaka, Ind.

R. M. Hawkins, Jr., formerly with the Standard Welding Co., Cleveland, Ohio, has entered the employ of the Hill Clutch Co. of Cleveland as Eastern representative and is connected with its New York sales office located at the Hudson Terminal building, 50 Church St., New York City.

Nathan B. Payne, who has been associated with Manning, Maxwell & Moore, Inc., New York City, for several years, was made manager of sales of the Davis-Bournonville Co., manufacturer of oxy-acetylene welding and cutting apparatus, beginning February 1.

Dr. Edward Goodrich Acheson of the International Acheson Graphite Co., Niargara Falls, N. Y., and one of the foremost inventors and chemists of the time, was recently honored by the Russian government. The Order of St. Ann was conferred on Dr. Acheson at the American Embassy in St. Petersburg, by order of the Czar.

* * *

OBITUARIES

David McNeely Stauffer, a civil engineer of some distinction, died at his home in Yonkers, February 6, aged sixty-seven years. Mr. Stauffer was for twenty-four years, editor of the *Engineering News*, and retired years ago.

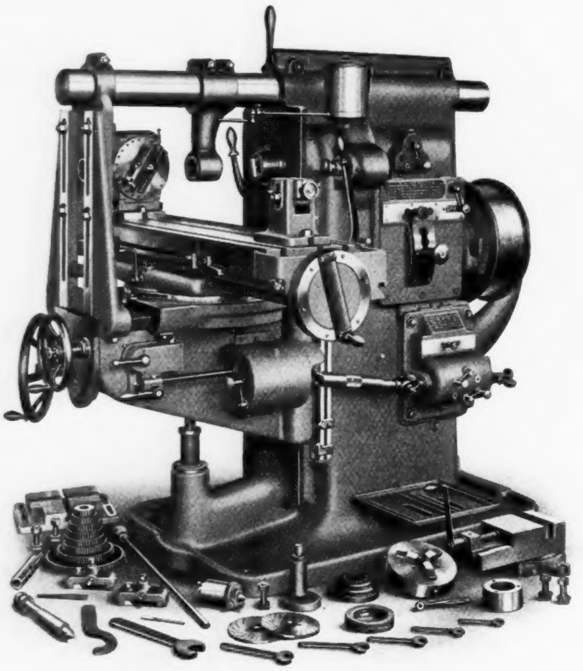
Edward L. Bronson, for several years master mechanic of the Shoe Hardware Co., Waterbury, Conn., died at his home in Waterbury aged fifty-three years. Mr. Bronson was for many years a foreman in the E. J. Manville Machine Co., of Waterbury.

George B. Lamb died February 21 at his home in Waterbury, Conn., aged sixty-four years. Mr. Lamb was vice-president of the Waterbury Farrel Foundry & Machine Co., and was formerly superintendent of its machinery department. He was the inventor of several improvements in hydraulic machinery, etc.

James B. Hammond, president of the Hammond Typewriter Co., and one of the pioneers of typewriter invention, died while on a yachting cruise at St. Augustine, Florida, January 27, aged seventy-four years. The Hammond typewriter, patented in 1884, had as a distinguished feature, a revolving type wheel instead of swinging type bars.

GUSTAF DE LAVAL

The well-known Swedish scientist and inventor, Dr. Gustaf De Laval, died in Stockholm, Sweden, after an unsuccessful operation, February 2. Dr. De Laval was born at Blasenborg, Sweden, in 1845. He was educated at the Royal Technical Institute in Stockholm where he graduated in 1866. He was then employed with the Stora Kopparberg Mining Co., and later, desiring to obtain a more extensive scientific training, he entered the University of Upsala, where for several years he studied physics and mathematics, and received the degree of Doctor of Philosophy. He then again entered the service of the mining company and worked out plans for the erection of a plant for the manufacture of sulphur. Later he



Investigate Design and Construc Parts of B. & S.

Study the parts and their functions. requisite for accuracy, efficiency, You will find they are the features give you a better understanding of designing and building machine tools.

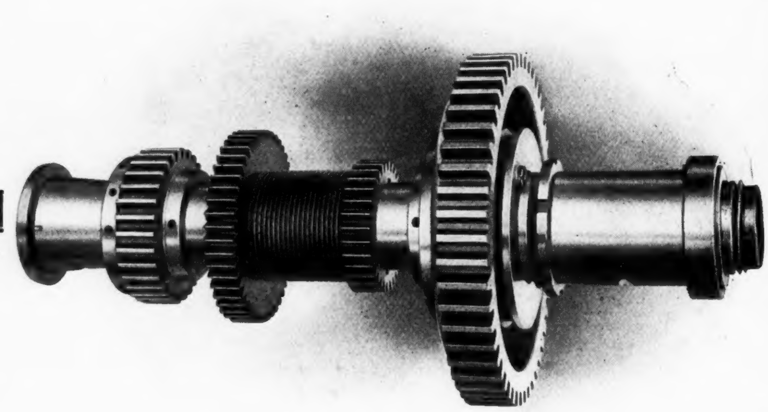
Spindle Drive in B. & S. Constant Speed Drive Milling Machines

B·S

This is one of the most important features of the constant speed type of machines, for it is essential that a maximum part of the power delivered to the machine be available at the spindle nose. The drive in our machines from the large wide face driving pulley to the spindle is through a direct spur gear train mounted on shafts of large diameter, that are firmly supported at points close to where pressure is applied. The gears are of large diameter, wide faces, and coarse pitches. In this connection we emphasize particularly the large back gears that transmit a very powerful and steady drive to the spindle when slow speeds are being used. All speed changing gears are hardened and the teeth are pointed to afford instant engagement. They are quiet running and highly efficient.

Note the large proportions of the spindle shown below. Observe the long, heavy boxes which are fitted with phosphor bronze. Power is delivered at the front of the spindle at all times, hence, torsion is eliminated.

Write for further information about these machines.

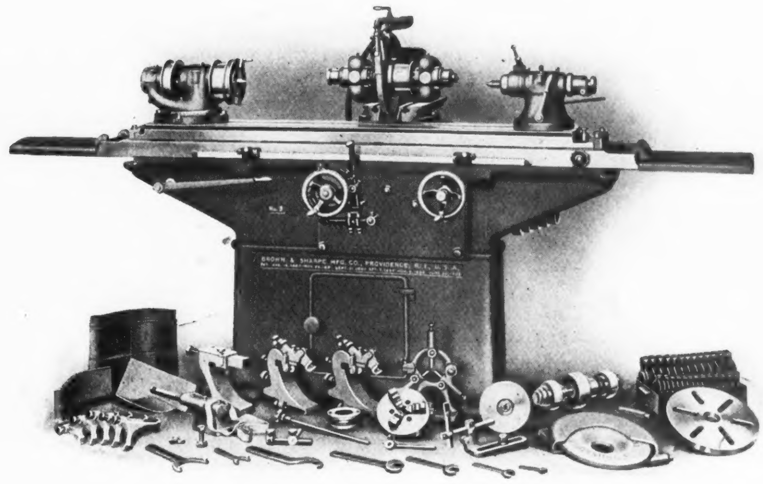


SEND FOR A 1913 GENERAL CATALOG

BROWN & SHARPE MFG. CO.,

Details in tion of Important Machine Tools

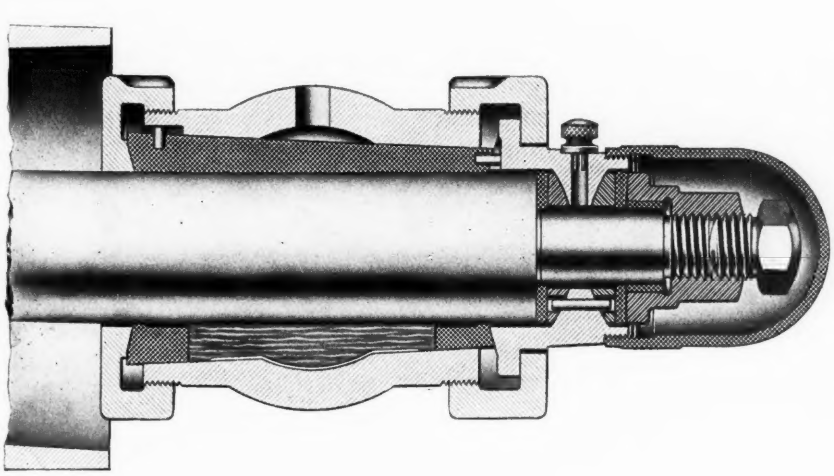
Pick out those that are conveniences, and durability. of our machines. It will also the B. & S. methods of



Wheel Spindle in B. & S. Universal and Plain Grinding Machines

Strength, rigidity, and high efficiency are all required at this point in a grinding machine. The spindle is of ample diameter and is hardened, ground, and lapped. Its manner of support in self-aligning phosphor bronze boxes that, in turn, are firmly mounted in the wheel stand, gives a rigid support for the wheel. Solid walls of metal that form a part of the base of the machine, extend beneath the wheel stand to the floor.

The cut below shows a section through one spindle bearing. The long phosphor bronze bearing and spherical box seat that keeps the bearing in perfect alignment are clearly illustrated. A felt pad, kept saturated with oil from the reservoir of the box, and pressed against the spindle by a spring, furnishes a constant and even lubrication to the bearing. Self-aligning end thrust washers, together with means for taking up end wear clearly show in the cut. Means are also provided for compensating for any wear in the cylindrical bearings.



Ask us for other points about these machines.

HAVE YOU READ PAGE 59

PROVIDENCE, R. I., U. S. A.

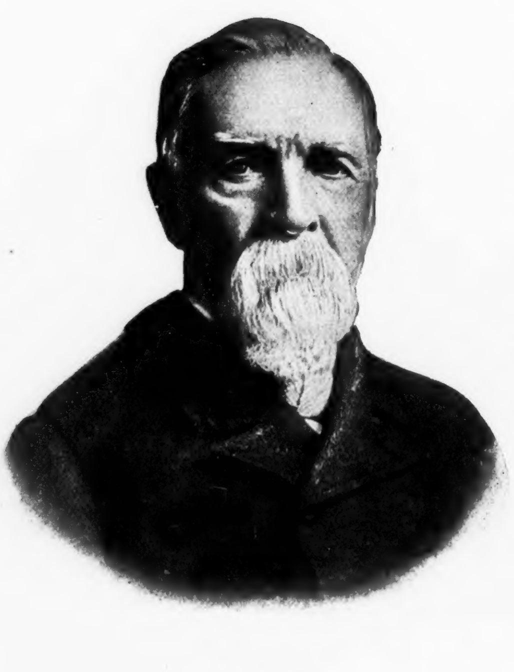
entered the service of the Kloster Iron Works, Germany, as mechanical engineer, and shortly afterward made his first two inventions—one relative to a new strainer which was to effect a more perfect separation of air in a Bessemer converter, and the other, a crucible for galvanizing purposes. He experimented on centrifugal machinery and this led to the invention of the centrifugal cream separator which is one of the two great inventions that are most often coupled with his name. The De Laval Separator Co., making the De Laval cream separators, has an extensive plant at Poughkeepsie, N. Y. He also perfected a number of other inventions in connection with a dairy apparatus, one, by means of which the percentage of butter fat in milk could be determined in a simple manner, for the purpose of establishing a uniform method of paying for milk. In the manufacture of the cream separator, he conceived the idea of a steam turbine as an ideal motor for driving the separator, which must itself run at an extremely high speed, and from this primary idea the De Laval steam turbine was developed about 1882. The first commercially practical De Laval turbine was built in 1883, and was used for driving a cream separator to which it was direct-connected. This first turbine, however, was of low efficiency. In 1888 he invented and used the diverging expansion nozzle in which the steam was completely expanded, and by means of which a much higher efficiency could be obtained. The De Laval steam turbine is made in this country by the De Laval Steam Turbine Co., Trenton, N. J. In addition to the invention of the cream separator and the steam turbine, Dr. De Laval worked on inventions of the most varying character, among others, methods for electrically separating the iron in iron ore. Dr. De Laval easily ranked among the great inventors of the age. He was a practical engineer with bold imagination and determination to overcome difficulties, and he probably pointed the way to many of the other inventors who have worked on the development and perfection of different types of the greatest of his inventions—the steam turbine.

JOHN FRITZ

John Fritz, iron and steel maker, having attained the age of ninety-one years, died at his home, South Bethlehem, Pa., on February 13, as the result of a long illness. He was born in Londonderry Township, Chester County, Pa., and his early life was spent on his father's farm in Londonderry, where he received his early education in the country schools of that district. His father combined the pursuits of farming and mill-wrighting, and Mr. Fritz's first mechanical experience was acquired in visitiing the cotton, spinning and weaving mills in the vicinity of his home, where his father was occasionally employed as a millwright. In October, 1838, at the age of fourteen years, Mr. Fiitz was apprenticed in general to learn the trades of blacksmithing and general machine work, in a shop in Parksburg, Chester Co., Pa. This shop was engaged in a variety of repair work on industrial and agricultural machinery, and here he obtained a varied knowledge of mechanical matters.

The iron and steel industry was being rapidly developed at this period and Mr. Fritz decided upon this field for his life's work. In 1884, he obtained a position in the mill of Moore & Hooven, Norristown, Pa.; the mill was, at that time, in course of construction and Mr. Fritz was engaged in erecting machinery. Rolling mill equipment at this time was in a crude state, and when the Moore & Hooven mill was placed in operation, a great deal of difficulty was experienced. The gearing used on the mills was particularly troublesome and Mr. Fritz became quite famous for his skill in repairing broken gear-teeth; this was made the subject of a special theatrical performance given in the opera house at South Bethlehem, Pa., on the occasion of Mr. Fritz's seventy-fifth birthday. The plot of the play was centered around the arrest of Mr. Fritz for "practicing dentistry without a license."

When the Moore & Hooven mill was first placed in operation and Mr. Fritz had obtained a general knowledge of the mechanical problems connected with rolling iron, he turned his attention to the studying of the subjects of puddling and rolling, and as his mechanical duties employed him constantly during the day, he devoted his evenings to studying the work of puddling and rolling in the mills. Little by little he picked up the principles of the industry and was placed in charge of the night shift of the Moore & Hooven mill. After remaining in this capacity for six months, he was transferred to the day shift. This was a considerable advancement, as it brought him into close personal touch with Mr. Hooven on all of the more intricate problems connected with the operation of the plant. An example of the accuracy of his observation may be obtained from the following: In the operation of the puddling furnaces, it was observed that a new furnace failed to give satisfactory results, but that after it had been in operation for a considerable length of time it worked much better. There was apparently no reason for this change in efficiency, but a careful study of the subject made by Mr. Fritz revealed the fact that the furnaces were kept in operation until the brick work of the roof was worn away to a thickness of about two inches. He arrived at the conclusion that the change in efficiency was due to the increased height of the furnaces, and acting upon this theory, had furnaces constructed of greater height.



John Fritz

Mr. Fritz worked with a single purpose in view—to obtain a thorough knowledge of the iron and steel industry—and this object frequently led him to make changes which were not financially desirable, in order that he might obtain experience in certain lines of work. An example of this occurred in 1849 when he left the Moore & Hooven Co. to associate himself with Reaves, Abbott & Co., who were building a mill at Safe Harbor. From this period on, Mr. Fritz made a number of changes with the view of securing desirable experience. In 1854, he went to the Cambria Iron Co., Johnstown, Pa., as manager. While engaged in this capacity, he developed the three-high rolling mill which is universally used in steel mills to-day. In July, 1860, he left the Cambria Co. to associate himself with the Bethlehem Iron Co., Bethlehem, Pa., and by 1864, he had become such a prominent figure in the iron industry that he was authorized by the government to organize a plant in the South for rolling rails to replace those torn up by the Confederate armies. Mr. Fritz drew plans for this plant and arranged for the equipment which was necessary, but did not personally superintend its installation or subsequent operation.

In 1864, the Bessemer process for the manufacture of steel was introduced into America, and at once attracted the attention of Mr. Fritz. Many experiments were made, but it appeared that the available ores were unsuitable for the conversion of iron obtained from them, into steel by the Bessemer process, owing to the high percentage of phosphorus which they carried. Mr. Fritz finally regarded this as an insurmountable barrier to the use of the Bessemer process and for some time gave up all thought of the subject. The trouble which was constantly being experienced by railroads with broken rails, however, was finally the cause of the decision of the Bethlehem Steel Co. to erect a plant for the production of Bessemer steel rails, in which four converters were originally installed. Much trouble was experienced when this plant was first placed in operation, but the persistent work, careful study and ingenuity of Mr. Fritz was finally the means of overcoming them, and it is to him that the industry is largely indebted for the perfection of this process as applied to iron smelted from American ores. Following upon the Bessemer process, came the Siemen's open-hearth process for the production of steel, and here again Mr. Fritz was an active figure. His name is also prominently associated with the introduction of the Whitworth process of making steel forgings, and the Schneider-Creusot process for the manufacture of armor plate in America.

Mr. Fritz was a member of the American Society of Mechanical Engineers and was president of that organization during the year 1896. He was made an honorary member of the Iron and Steel Institute of Great Britain in 1893, and was awarded the Bessemer gold medal for his valuable service in the manufacture of iron and steel; in 1909, he was made honorary vice-president of that institution for life. He was one of the original trustees of Lehigh University when the institution was founded in 1866 and remained in that capacity during the greater part of his active career. In 1909, he founded the John Fritz Engineering Laboratory of Lehigh University. Various honorary degrees were awarded to him in commemoration of his work in the iron and steel industry, and on the occasion of his eightieth birthday, the

John Fritz gold medal was established, which is awarded for valuable service in scientific or industrial work.

A characteristic feature of Mr. Fritz was his ability to co-operate with his associates; he was not below taking the advice of those who occupied humble positions in the different industrial establishments with which he was connected. It is probably due to this willingness to take advice that a portion of his great success was due, and it certainly endeared him to the iron and steel fraternity among the members of which he was popularly known as "Uncle John."

* * *

COMING EVENTS

May 15-16.—Semi-annual meeting of the National Machine Tool Builders' Association at the Hotel Astor, New York City. James H. Herron, secretary, 2041 East Third St., Cleveland, Ohio.

May 20-23.—Spring meeting of the American Society of Mechanical Engineers in Baltimore, Md. Hotel Belvedere, headquarters. Layton F. Smith, past president of the Baltimore Engineers Club, chairman of the local committee. Calvin W. Rice, secretary, 29 W. 39th St., New York City.

May 26-29.—Annual convention of the Master Boiler Makers' Association at Chicago. Harry D. Vought, secretary, 95 Liberty St., New York City.

June 10.—Departure from New York City, of American Society of Mechanical Engineers party to attend joint meeting with Verein deutscher Ingenieure in Leipzig, Germany, beginning June 23.

June 11-13.—Annual convention of the American Railway Master Mechanics' Association at Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago, Ill.

June 16-18.—Annual convention of the Master Car Builders' Association at Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago, Ill.

August 16-23.—Second Annual Gas Engine Show of the National Gas Engine Association at Kansas City, Mo. H. R. Brate, secretary, Lakemont, N. Y.

October 14-16.—Annual convention of the Allied Foundrymen's Associations. Hotel La Salle, headquarters, Richard Moldenke, Watchung, N. J., secretary.

SOCIETIES, SCHOOLS AND COLLEGES

Williamson Free School of Mechanical Trades, Williamson School P. O., Delaware Co., Pa. Bulletin No. 10 on carpenters' trade course; Bulletin No. 11 on operating engineers' trade course.

Massachusetts Institute of Technology, Boston, Mass. Catalogue for 1912–13, containing the official roster, list of students, statements of the requirements of admission and description of courses of instruction.

University of Vermont and State Agricultural College, Burlington, Vt. Catalogue for 1912–1913, containing also announcements for 1913–1914 and official roster, list of students, conditions of admission, course of instruction, etc.

American Society of Swedish Engineers, 271 Hicks St., Brooklyn, N. Y., celebrated its twenty-fifth anniversary with a dinner, on the evening of February 11. Mr. C. J. Mellin, of the American Locomotive Works, Schenectady, N. Y., who was the first president of the society, spoke of its early history and gave a review of its activities during the past twenty-five years. The object of the society is to bring together, in a professional and social way, men of Swedish nationality engaged in the engineering field, and to assist young technical men who have just arrived in the United States in obtaining suitable work, and adding to their experience. The society has now nearly three hundred members, of which about sixty reside in New York and vicinity. In 1908, it acquired the building it now occupies in Brooklyn, where its meetings are held and where it has a library and reading room. Architect N. L. Malmros, president, spoke for the future of the society. The Swedish Minister to the United States, W. A. F. Ekengren, was present as a guest of honor, as was also the Swedish Consul in New York City, M. Clarholm.

NEW BOOKS AND PAMPHLETS

Handbook of Gasoline Automobiles. 187 pages, 7¾ by 5¼ inches. Illustrated. Published by the Automobile Board of Trade, New York City.

The 1913 edition of this publication contains illustrations and specifications of the pleasure and commercial gasoline motor cars built by seventy-four American concerns.

The Gasoline Engine on the Farm. By Xeno W. Putnam. 527 pages, 7½ by 5⅜ inches. 179 illustrations. Published by Norman W. Henley & Son, New York City. Price, $2.50.

This book is a practical treatise on the construction, repair, management and operation of gasoline engines as applied to a great variety of farm implements and machinery.

German on a Trip to Germany. By Max Hirschfelder. 9¼ by 6⅛ inches. Published by Self Educator Publishing Co., Scranton, Pa. Price, 15 cents, per number.

This series constitutes a text for the home study of German. It is to be published in forty installments which will appear monthly, and the first four installments are now available.

The Electron Theory of Magnetism. By Elmer H. Williams. 66 pages, 6 by 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill., as Bulletin No. 62.

The bulletin is a mathematical discussion of the new theory of magnetism, tracing the experimental evidence leading to the development of this theory, defining its present status and pointing out certain phenomena which the theory in its present form fails satisfactorily to explain.

Essentials of Electricity. By W. H. Timbie. 271 pages, 7¼ by 4¾ inches. 222 illustrations. Published by John Wiley & Sons, New York City. Price, $1.25 net.

This book was written with the view of providing a text on the subject of direct-current electricity for the use of wire-men and others employed in the electrical trades. The subject of electricity is one of which many mechanical men require a certain amount of knowledge, and the present text should be well suited to meet the requirements of such readers.

Engineers Directory for 1913. 1552 pages, 6¾ by 4⅜ inches. Published by the Crawford Publishing Co., 537 South Dearborn St., Chicago, Ill. Price, $5.

This book is a directory of the plumbing, heating, lighting, power-plant and mill supply industries of the United States. It is intended for the use of jobbers, manufacturers and retailers of supplies used in these industries, and should be of considerable value in promoting sales in these trades and in other work which requires the use of a directory of this kind.

Handbook of English for Engineers. By Wilbur Owen Sypherd. 314 pages, 6¾ by 4⅝ inches. Published by Scott Foresman & Co., Chicago and New York. Price, $1.50.

It is quite generally recognized that the technical schools fail to turn out men who are competent to write satisfactory reports on engineering work. The present text has been developed with the view of affording a textbook on the subject of English especially adapted for use in technical schools. It is also well suited for the use of engineers who wish to improve their style of writing by home study.

Oxy-acetylene Torch Practice. By J. F. Springer. 140 pages, 5 by 7¼ inches. Illustrated. Published by the Richardson Press, 56 Leonard St., New York City. Price $2.50.

The work treats of ordinary welding; preheating for oxy-acetylene welding; restoration of steel; welding copper and aluminum; sheet metal welding; welding tanks, retorts, etc.; welding as a calking process; boiler work; machine welding; metal cutting with the oxy-acetylene flame, oxy-acetylene cutting machines, etc. Oxy-acetylene welding and cutting processes have rapidly acquired commercial importance, and this book should be welcome as a practical treatise on a comparatively new art.

Tafelbätter aus den Figuren der *Zeitschrift des Vereines deutscher Ingenieure.* (Reprinted plates from the Journal of the Society of German Engineers.) Eight plates, 12½ by 19 inches. Heavy paper cover. Published by Verein Deutscher Ingenieure, Charlottenstr. 43, Berlin N. W., Germany. Price, to members of the Society of German Engineers, postpaid, 45 cents; to others, 60 cents.

The *Zeitschrift des Vereines deutscher Ingenieure*—the journal of the Society of German Engineers—contains a great many complete assembly and detail drawings of machines built and in successful operation. In response to many requests reproductions of the drawings pertaining to certain special subjects have been reprinted in convenient form so that designers and others can refer to them more easily than by consulting the rather bulky volumes of the journal itself. For this reason, the society has begun to publish a series of collections of plates. The size of the plates is about 12½ by 19 inches, but they are so folded that they can be carried in the pocket, the width when folded being only 5 inches. These reproductions of noteworthy designs should be of particular value to designers. The first two collections in the series relate to locomotives and railway cars, and hoisting and conveying machinery.

Book of Standards. 559 pages, 4 by 6½ inches. Published by the National Tube Co., Pittsburg, Pa. Price, $2.

The 1913 edition of the Book of Standards which was briefly noted in the February number deserves a more extended listing of its contents. The book has been four years in preparation and contains a large amount of original data derived from thousands of experiments made by the company. It is strictly a pipe handbook and should be valuable to the trade. A brief description is given of welding tubes and pipe; methods of manufacture and characteristics; following which are tables on standard black and galvanized pipe; line pipe extra strong and galvanized; standard Boston casing; inserted joint casing; Boston casing—Pacific couplings; California diamond BX casing; oil well tubing; California special external upset tubing; California drive pipe; bedstead tubing; flush joint tubing; Allison vanishing thread tubing; special rotary pipe; air line pipe; locomotive boiler tubes; standard boiler tubes and flues; Matheson joint pipe; Converse lock-joint pipe; Kimberley joint pipe; square pipe; weights of piping per foot; properties of pipe; hydro-static test pressures; illustrations of various forms of pipe joints; standard specifications; locomotive boiler tube tables; wrought-iron pipe bends; valves and fittings; tubular electric line poles; wrought pipe nipples, black and galvanized; pipe hand railings; Shelby seamless cylinders; seamless steel specialties; properties of Shelby seamless tubing; strength of tubes; pipes and cylinders under internal fluid pressure; collapsing pressures; pipe columns; mechanical properties of solid and tubular beams; flow of water in pipes with table of loss of head by friction; measurement of flowing water; water power; contents of pipes and cylinders; physical properties of gases; flow of gas in pipes under low and high pressures; properties of saturated steam and superheated steam; flow of steam; properties of air; flow of compressed air, etc. The book is printed on Canterbury bible paper, and while containing 559 pages is only ⅜ inch thick. It is adapted to be carried in the pocket and is completed with a copious index, making reference to the data easy. A valuable feature of the book is a glossary of terms used in the pipe fitting trade.

NEW CATALOGUES AND CIRCULARS

W. E. Caldwell Co., Louisville, Ky. Catalogue No. 1 on friction clutches.

L. S. Starrett Co., Athol, Mass. Circular of Starrett vernier calipers and directions for reading the vernier.

Bristol Co., Waterbury, Conn. Catalogue No. 1200 on Bristol class II recording thermometers and accessories.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin No. 124 on pneumatic riveting, chipping, calking and stone hammers.

Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass. Circular of 13-inch double back-geared lathe with quick change gear attachment.

Potter & Johnston Machine Co., Pawtucket, R. I. Catalogue No. 21 on manufacturing automatic chucking machines 5-A and 6-A models.

Bristol Co., Waterbury, Conn. Condensed catalogue No. 160 of Bristol recording instruments for pressure, temperature, electricity, speed, time, etc.

Cling-Surface Co., 1018 Niagara St., Buffalo, N. Y. Pamphlet on "Cling-Surface" treatment for transmisison rope, illustrating installations on which "Cling-Surface" has been used with satisfaction.

Standard Electric Tool Co., Cincinnati Ohio. Bulletins D-8 and D-9 on "Standard" high-power direct current portable electric drills and "Standard" high-power two- and three-phase alternating current portable electric drills, respectively.

Hermann Boker & Co., 101 Duane St., New York City. Catalogue No. 1 on "Novo" high-speed steel, special chrome stetel, steel balls, superior self-hardening steel, special turning and finishing steels, N. C. S. steel, B. N. D. steel, composite steel, German process sheets, oil furnaces, etc. Instructions for hardening "Novo" steel and illustrations of the forging of a lathe tool are included.

Buffum Tool Co., Louisiana, Mo. General catalogue No. 2 on tools, comprising chisels; punches; hammers; handles; carpenters' tools; engineers', machinists,' automobile and motor boat tools; screw drivers; wrenches, pincers, pliers and eelctricians' tools; boilermakers' and structural ironworkers' tools; blacksmith and farriers' tools; plumbers' tools; bricklayers,' plasterers' and stone masons' tools; cement workers' tools; tinners' tools; warehouseman's tools; butcher and packing house tools; garden, farm and lawn tools; household tools and appliances, etc.